ATTACHMENT H

STORMWATER POLLUTION PREVENTION PLAN

STORMWATER POLLUTION PREVENTION PLAN
~~FOR CONSTRUCTION OF~~

TONY M UNDERGROUND URANIUM MINE
SECTIONS 8, 9, 16, 17, AND 21,
TOWNSHIP 35 SOUTH, RANGE 11 EAST OF THE
SALT LAKE MERIDIAN
GARFIELD COUNTY, UTAH 84726, USA

Prepared for

DENISON MINES

~~INTERNATIONAL URANIUM (USA) CORPORATION (IUSA)~~
Denison Mines (USA) Corp. (DUSA)

Prepared by

TETRA TECH INC.

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Tetra Tech Project ~~P3374.005.02.02~~ **181736.101.05**

June 4, 2008

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information is, to the best of my knowledge and belief, true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

In addition, I certify that the Tony M Mine is a zero discharge facility, and furthermore will not knowingly discharge produced mine water with stormwater runoff.

Harold R. Roberts

~~IUSA~~ **DUSA** Project Manager

SITE CONTACT INFORMATION

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Revision Schedule

This stormwater pollution prevention plan (SWPPP) should be revised and updated to address changes in site conditions, new or revised government regulations, and additional on-site stormwater pollution controls.

All revisions to the SWPPP must be documented on the SWPPP Revision Documentation Form, which should include the information shown below. The authorized facility representative who approves the SWPPP should be an individual at or near the top of the facility's management organization, such as the president, vice president, construction manager, site supervisor, or environmental manager. The signature of this representative attests that the SWPPP revision information is true and accurate. Previous authors and facility representatives are not responsible for the revisions.

SWPPP Revision Documentation Form

Number	Date	Author	Company Representative Signature
0			
1	May 8, 2008	Tetra Tech, Inc.	
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ACRONYMS AND ABBREVIATIONS

BACT	Best Available Control Technology
BLM	U.S. Bureau of Land Management
BMP	Best Management Practice
CFR	Code of Federal Regulations
CGP	Construction General Permit
CKD	Cement Kiln Dust
CWA	Clean Water Act
DUSA	**Denison USA**
EPA	U.S. Environmental Protection Agency
ESC	Erosion Sediment Control
FEMA	Federal Emergency Management Agency
~~IUSA~~	~~International Uranium (USA) Corporation~~
MSDS	Material Safety Data Sheet
MSGP	**Multi-Sector General Permit**
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollution
NOI	Notice of Intent
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resource Conservation Service
ρCi/L	PicoCuries per Liter
SITLA	State Institutional Trust Land Administration
SWPPP	Stormwater Pollution Prevention Plan
TDS	Total Dissolved Solids
TMDL	Total Maximum Daily Load
UDAQ	Utah Division of Air Quality
UDEQ	Utah Department of Environmental Quality
UDOGM	Utah Division of Oil, Gas, and Mining
UDOT	Utah Department of Transportation
UDWQ	Utah Division of Water Quality

USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
USGS	United States Geologic Survey
WRA	Waste Rock Area

LISTING OF REFERENCED WEBSITES

BLM Utah Wilderness Inventory – http://www.access.gpo.gov/blm/utah

EPA BMPs – http://cfpub.epa.gov/npdes/stormwater/swppp.cfm

EPA CFR Title 40 – http://www.epa.gov/epahome/cfr40.htm

EPA EnviroMapper – http://maps.epa.gov/enviromapper/

EPA NOI – http://cfpub.epa.gov/npdes/stormwater/noi/noisearch.cfm

EPA NPDES – http://www.epa.gov/npdes

EPA Water Quality Standards – http://www.epa.gov/wqsdatabase

FEMA – http://msc.fema.gov/webapp/wcs/stores/

MSDS – http://www.ilpi.com/msds

NRCS Web Soil Survey – http://websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx

UDEQ Division of Air Quality – http://www.airquality.utah.gov/

UDEQ Emergency Spill Phone Numbers – http://www.superfund.utah.gov/spills.htm

UDEQ General Multi-Sector Industrial Storm Water Permit
http://www.waterquality.utah.gov/UPDES/stormwaterind.htm

UDEQ TMDLs – http://www.waterquality.utah.gov/TMDL/index.htm#addinfo

USFWS Endangered Species –~~http://mountainprairie.fws.gov/endspp/CountyLists/UTAH.htm~~
http://www.fws.gov/mountain-prairie/endspp/countylist/Utah (last updated November 2007)

1 ~~CONSTRUCTION~~ ENVIRONMENTAL SUMMARY

1.1 Summary

~~International Uranium (USA) Corporation (IUSA)~~ **Denison Mines (USA) Corp. (DUSA)** ~~proposes to~~ **has** reopen**ed** and redevelop**ed** the Tony M Mine, an underground uranium mine previously operated by Plateau Resources. The Tony M Mine is located approximately 50 miles south of Hanksville and 15 miles north of the Bullfrog Marina (Figure 1).

Plateau Resources operated the mine from 1977 into the early 1980s, when operations were suspended due to low uranium prices. Plateau Resources developed more than 17 miles of underground workings. The Tony M portals are on State land. The mine shop, change house, and surface buildings **were built** ~~will be~~ on public land managed by the Bureau of Land Management (BLM). From 1995 to 2003, the surface facilities and evaporation pond of the Tony M Mine were reclaimed in stages.

~~IUSA~~ **DUSA** has purchased claims and entered into a lease agreement in order to conduct mining operations on the property associated with the Tony M Mine. ~~IUSA~~ **DUSA** purchased the claims at various times ~~over the past two years~~ between **2004 and 2006**, and entered into a lease agreement with the Utah State Institutional Trust Land Administration (SITLA) in April, 2005. The Bullfrog resource was acquired in 1997. ~~IUSA~~ **DUSA** did not purchase claims associated with the Frank M site or facilities associated with the Plateau Resources' Ticaboo Mill.

Both the Utah Division of Oil, Gas, and Mining (UDOGM) and the BLM have agreed to evaluate the proposed mine development in three phases. ~~IUSA~~ **DUSA** has an approved UDOGM Exploration Permit No. E/017/044, and an approved BLM Notice of Activities **UTM-80022** for initial exploration and investigation work at the site. **In addition to the following permits that are relative to stormwater activities; Groundwater Discharge Permit by Rule issued for Phase 1, March 22, 2007,**

Stormwater Diversion Construction Permit issued by Utah Division of Environmental Quality (UDEQ) Division of Water Quality, and a pending Multi-Sector General Permit (MSGP) for Stormwater Discharge Associated with Industrial Activities.

On approximately the same area previously disturbed and reclaimed by the former operator, ~~IUSA~~ **DUSA** ~~plans to commence Phase I of a three-phase plan during the second quarter of 2007.~~ **has begun construction of Phase 1 of a three phase construction plan**. Phase ~~I~~**1** consists of reactivating the existing Tony M Mine workings, extending underground declines and laterals further to the north, reestablishing the mine ventilation and dewatering systems, and constructing new surface support facilities ~~during a two- to three-year period~~. ~~IUSA~~ **DUSA** ~~is currently working with UDOGM to develop the permit documents and with BLM to develop the National Environmental Policy Act (NEPA) resource baseline and clearances for Phase I of the project (Figure 2).~~ **completed the Environmental Assessment (EA) which was submitted to the BLM on August 27, 2007 and a final Dision Record (DR) was issued November 23, 2007.**

Phase II consists of developing resources on claims just to the north of the existing mine workings, including new surface facilities. Phase III involves extending mine workings and constructing new surface facilities to develop the Bullfrog claims located further to the north. Phase II and III would involve construction of some additional surface features, such as vents, portals or shafts, and access roads. Phase II **is scheduled to begin December 2008, DUSA will begin seeking permits and clearance for Phase II in June 2008**. ~~and~~ **Phase** III ~~have~~ has not been defined or scheduled; and ~~IUSA~~ **DUSA** is not currently seeking permits or clearances for ~~these~~ **this** Phase~~s~~. This Stormwater Pollution Prevention Plan (SWPPP) is for the construction of Phase I only.

This SWPPP conforms to the U.S. Environmental Protection Agency (EPA) Region 8 Construction General Permit (CGP) requirements under the Clean Water Act (CWA) National Pollution Discharge Elimination System (NPDES); **and the Utah Division of Water Quality MSGP for Stormwater Discharge Associated with Industrial Activities, Sector G Metal Mines (Ore Mining and Dressing). The Tony M Mine will be a zero discharge facility, all produced mine water will be diverted to the proposed evaporation pond and therefore will not be required to conduct analytical monitoring. The MSGP permit will need to be renewed every three years.**

The proposed construction will not take place on tribal lands or on lands regulated under any other authority; therefore, no tribal or additional municipal standards apply.

1.1.1 Project Description

The Phase I project area is within Township 35 South and Range 11 East of the Salt Lake Meridian; including Sections 8, 9, 16, 17, and 21 (Figure 3). As shown on Figure 3, the underground mine workings are located in portions of Sections 8, 9, and 16. Surface disturbance above the mine is limited to vent shafts and their access roads. The pond area is located in the east half of Section 17. The surface facilities will be located primarily in the north half of Section 21. There will be no processing activities on site. The ore will be transported to the White Mesa Mill at Blanding, Utah.

The proposed facilities are as follows.

- Waste rock area (WRA)
- Ore bins and stockpile areas
- Topsoil stockpile areas
- Surface drainage and control structures
- Fuel and oil storage areas
- Mine offices
- Maintenance shop and warehouse
- Designated parking areas and storage yards
- Mine access roads and pads
- Electrical generators
- Air compressor station
- Well water system
- Septic system (including sand trap)
- Solid waste storage (trash, scrap metal, batteries)
- Propane heating system

Listed below are the approximated areas to be disturbed during the Phase I process.

Actual mining	~~1.4~~**1.2** acres (portal and vent hole)
Overburden/waste dumps	7.6 acres (WRA)
Ore and product stockpiles	~~1.2~~**5.7** acres (ore stockpiles 1-3)
Access/haul roads	~~2.2~~**1.7** acres (excludes existing roads)
Associated on-site processing facilities	0
Tailings disposal	0
Other	~~35.6~~**35.2** acres (evap. pond, buildings, yards)
Existing roads	**0.4 (previously constructed)**
Total disturbed area	~~48~~**51.8 acres**

The ~~proposed~~ clay liner in the evaporation pond ~~will be~~ **is** approximately 18 acres. The ~~proposed~~ impervious area from support facilities ~~at most~~ **are approximately** 3 acres. The total fill area ~~will be~~ **is** approximately ~~15~~**14** acres from the WRA, stockpiles and topsoil piles. The volume of fill will vary ~~through time as the~~ **with** mine ~~operates~~ **operations**.

DUSA does not plan to conduct any milling, metallurgical or other process operations at the Tony M Mine site. The Tony M Mine will be a zero discharge facility; all produced mine water will be diverted to the proposed evaporation pond and evaporated (Figure 3).

1.1.2 Existing Site Conditions

The Tony M Mine is situated on the southern flank of the Henry Mountain Range in southern Utah. The surface mine facility sits at the base of ~~Shitamaring~~ **Shootamaring** Canyon with steep red sandstone walls extending vertically on either side of the facility. Ephemeral Shitamaring Creek (Creek) traverses the project area from north to south. The soil types, sparse vegetation, and infrequent, high-intensity rainfall events are contributing factors to the relatively high erosion rates in the area.

Shitamaring Creek runs to the east of the existing county road that bisects the project area (Figure 3). An unnamed tributary to Shitamaring Creek runs to the south of the surface mine facilities area and joins the main stem at the southern end. Two additional unnamed tributaries are located to the east and west of the evaporation pond. These tributaries discharge to Shitamaring Creek as well.

Surface water runoff from the mine area generally flows to the east and south toward Shitamaring Creek. Shitamaring Creek is a first order drainage; the unnamed tributary south of the mine and the unnamed tributaries east and west of the evaporation pond are second order drainages. The Federal Emergency Management Agency (FEMA) does not have floodplain coverage for this area; therefore, floodplain mapping information is not included in this report (FEMA 2006).

The soils are predominantly derived from shale and sandstone with rock outcrops. Sagebrush, black brush, Mormon tea, grass, and scattered junipers cover the foothills, while cottonwood, tamarisk, and willow dominate the canyon riparian areas (BLM 2006a).

1.1.3 Adjacent Areas

The Phase I project area is contained within the Shitamaring Creek watershed. The Shitamaring watershed discharges to Hansen Creek, which drains to the San Juan River, and ultimately to Lake Powell which is approximately 15 miles south of the mine site (United States Geological Survey 2000). The Shitamaring Creek watershed is approximately 25,315 acres and is attributed to the Upper Lake Powell hydrologic unit with a code of 14070001 (EPA 2006a).

The project area is on and surrounded by state and federal land. The major transport route to the site is Highway 276, which is approximately 2.6 miles east.

1.1.4 Critical Areas

Stormwater runoff from the Phase I area will flow to the Shitamaring Creek. Best management practices (BMPs) ~~will be~~ **are** implemented to prevent sediment and other pollutants from entering the receiving waters. Typical BMPs at the site ~~may~~ include but are not limited to:

- Silt fences,
- A temporary drainage ditch,
- A temporary sedimentation basin,
- Riprap,
- A permanent diversion channel,
- An evaporation pond,
- Vegetated buffers,

- Preserving natural vegetation,
- Rough-cut grading,
- Revegetation,
- Permanent mulching,
- Construction road/parking area stabilization,
- Straw bales,
- Stockpile protection,
- Check dams,
- Earth dikes,
- Drainage swales,
- Stockpile seeding,
- Gradient terraces,
- Grass-lined channel and ditches,
- Slope reduction,
- Topsoil placement,
- Contour ripping,
- Filter fabric inlet protection,
- Excavated gravel inlet protection,
- Block and gravel inlet protection, and
- Outlet protection.

The Shitamaring Creek watershed has not been assessed by the Utah Division of Water Quality (UDWQ). Since an assessment has not been completed, total maximum daily loads (TMDLs) for the watershed have not been established by UDWQ or the EPA (UDEQ 2006a). The designated uses of tributaries of Lake Powell, unless specified otherwise, are agricultural, secondary recreation, and warm water aquatic life (EPA 2006b). Water quality standards may be found in Appendix A.

Groundwater discharged to the surface during the dewatering process has elevated concentrations of dissolved solids and sulfate as well as elevated radionuclide activity levels. (The groundwater permit-by-rule exception letter ~~has been~~ **was** ~~submitted to~~ **signed by** UDWQ **on March 22, 2007**.)

The presence of uranium at the mine site is not expected to pose a significant risk to human health or the environment. The level of radioactivity in the waste rock is similar to background levels. Temporary ore stockpiles may contain higher activity than background levels, but only potential exposure would be maintained as low as is reasonably achievable. The host rock for the ore is primarily expected to be sandstone, which is not considered an acid former. Infiltration and transport of these relatively immobile elements from the surface to the groundwater is highly unlikely due to the arid environment and the stratigraphy. BMPs ~~will be~~ **were** implemented to prevent stormwater runon to these areas and to eliminate the possibility of either erosion or runoff of potentially contaminated water.

The surface disturbance, the lack of vegetation, the noise of moving equipment, and the increased presence of humans is likely to result in temporary displacement of wildlife. No riparian areas and no threatened, endangered, or sensitive plant or wildlife species have been identified within the project area. However, federally-listed threatened and endangered species are within Garfield county and are listed as follows (United States Fish and Wildlife Service 2006):

- Endangered species: Autumn Buttercup, Bonytail[1,2], California Condor[3], Colorado Pikeminnow[1,2], Humpback Chub[1,2], Razorback Sucker[1,2], Southwestern Willow Flycatcher
- Threatened species: ~~Bald Eagle,~~ Jones Cycladenia, Maguire Daisy, Mexican Spotted Owl[1], Utah Prairie Dog, Ute Ladies'-tresses
- Candidate specie: **Western** Yellow-billed Cuckoo[4]

Notes:

1 There are designated critical habitat for the species within Garfield County, Utah.

2 Water depletion from any portion of the occupied drainage basin are considered to adversely affect or adversely modify the critical habitat of the endangered fish species, and must be evaluated with regard to the criteria described in the pertinent fish recovery population.

3 Experimental non-essential population.

4 Distinct population segment in Utah.

Since the tributaries located in Phase 1 of the Tony M Mine are ephemeral, notes 1 and 2 will not apply.

Historic and more recent water quality data for the groundwater within the mine indicate:

- the total dissolved solids (TDS) range from 1,820 to 5,810 milligrams per liter,
- the sulfate levels range from 1,150 to 4,050 mg/L, and
- gross alpha ranges from 50 to 220 picoCuries per liter (ρCi/L).

The Utah TDS water quality standard for stock watering is 2,000 mg/L. The measured TDS and sulfate levels are lower than those observed in the Great Salt lake, where water can be consumed by livestock and wildlife on a limited basis without harm. The Utah stock watering water quality standard and aquatic wildlife standard for gross alpha is 15 ρCi/L. Other measured water quality parameters are generally within the regulatory standards for both livestock and wildlife. Mitigation measures will consist of fencing the pond to preclude access by livestock and larger wildlife. Waterfowl are expected to be limited to flyovers, as the site is located near Lake Powell. The disruption of wildlife habitat will be temporary and cessation of mine-related activities, followed by reclamation, will restore the suitability for wildlife.

1.1.5 Soils

The soils within the project area are identified as the Glenberg family, the Badland-rock outcrop complex, and the Rizno, warm-rock outcrop complex (Natural Resource Conservation Service [NRCS] 2006). Each of these soils is described in greater detail below.

The Glenberg family soil (mapping unit 36) is found within the floodplain of intermittent streams and derives from sandstone and shale alluvium. This soil is characterized as a fine sandy loam with a depth of 60 inches. It has a low to moderate susceptibility to erosion, and has a wind erosion rate of 86 tons per acre per year. The Glenberg family soil is well-drained with a moderate to high rate of water transmission.

The Badland-rock outcrop complex (mapping unit 3) is the dominant soil type in the main surface facilities area. This silty clay soil may be found on hill slopes. The Badland soil is characterized as a soil with low susceptibility to erosion, and has a shallow depth of 12 inches. While this soil does not easily erode, it has a high potential to produce runoff due to its slow infiltration rate when thoroughly wet.

The Rizno, warm-rock outcrop complex (mapping unit 83) is a well-drained, fine sandy loam with low to moderate susceptibility to erosion, and a wind erosion rate of 86 tons per acre per

year. This soil is found atop mesas and hill slopes as aeolian deposit and derives from sandstone. Its characteristic depth is 27 inches.

1.1.6 Erosion Problem Areas

Areas of potential erosion include the downstream dam slope, the topsoil stockpiles, the WRA slope, and the ore stockpiles. The remaining areas are relatively flat with low potential for erosion.

The dam embankment will be stabilized by seeding disturbed areas after reconstruction is complete. Topsoil stockpiles will be seeded during the first fall planting season after the soil is stockpiled. Some erosion will occur on the WRA slopes and the sides of the ore stockpiles as they will be in a state of continual change and disturbance during operations. The impact from erosion will be minimized by installing sediment control measures. Erosion from the WRA, topsoil stockpiles, and the ore stockpile will be captured by a temporary drainage ditch located along the west side of the county road (Figure 4). This ditch will discharge into a temporary sedimentation pond, ~~which will be placed~~ **constructed** in the flow line of the temporary drainage ditch which leads to a tributary of the Creek. Silt fences or equivalent protection ~~may also be~~ **was** installed in areas prone to erosion. Emergency spillway, channels, and slopes that **are** ~~will be~~ subjected to the **erosive** action of moving water **were** ~~will be~~ armored with riprap **for** ~~or approved~~ slope erosion protection.

During the initial stage of mine operations, the crews will be relatively small and surface impacts will also be correspondingly small. To reduce erosion, the WRA and building areas **are being** ~~will be~~ expanded in an incremental manner. Topsoil and vegetation **are being** ~~will be~~ removed only from those areas needed to support the mine's immediate needs. The topsoil piles created during clearing operations **are being** ~~will be~~ seeded, and, if necessary, silt fences will be constructed around their perimeter.

1.1.7 Construction Phasing

~~IUSA~~ **DUSA** plans to reopen the mine using a three-phased approach. Phase I consists of reconstructing the surface facilities and further developing the underground workings utilizing the existing declines. Phases II and III involves developing the northern extent of the ore deposit,

which will require construction of production shafts and additional roads and surface facilities. However, Phases II and III are contingent on Phase I and are not included in this SWPPP.

1.1.8 Construction Schedule

The construction **of the mine facilities and evaporation pond began** ~~is planned to commence~~ in ~~April, 2007.~~ **November 2007.** ~~During April, the~~ **dDewatering began in early December 2007**~~process will begin as well as the construction of the evaporation pond.~~ The area **was** ~~will be~~ prepared for workers with the installation of temporary trailers and the rehabilitation of the well and septic system. During ~~May~~ **December 2007**, generators, air compressors, fuel tanks, and MgCl2 tanks will be installed. **It is anticipated that a used oil tank will be installed during the summer of 2008.** During ~~June~~ **the winter of 2007 - 2008**, the channels, sedimentation basin, ore slots, and access roads **were** ~~will be~~ constructed. **Ore production began in September of 2007.** ~~By July 2008, it is anticipated that the WRA and the ore stockpile will be in use, and the warehouse and shop will be constructed.~~ **The** ~~A tentative~~ construction schedule is provided in Appendix B.

1.1.9 Financial/Ownership Responsibilities

The project is located on public lands managed by the BLM and state lands managed by SITLA. ~~IUSA~~ **DUSA** purchased a State Mineral Lease for the Tony M Mine and is responsible for bonds and other financial securities. Harold Roberts, ~~IUSA~~ **DUSA Executive** Vice President ~~Corporate~~ **US Operations** ~~Development,~~ is recognized as the Project Manager. ~~Jim Fisher is the Mine General Superintendent.~~ **Danny Flannery is the Tony M Mine Compliance Technician.**

Prior to the commencement of Phase I, ~~IUSA~~ **DUSA** ~~has committed to posting~~ **posted** a **notice** sign ~~or other notice~~ near the main entrance to the site. The notice ~~will~~ contain**s** a copy of the stormwater notice of intent (NOI), the contact person who updates and maintains the SWPPP, and the location of the SWPPP. The SWPPP will remain on-site throughout the duration of the Tony M Mine operation and will be maintained with inspection record, site visits, and BMP maintenance and updates.

1.1.10 Engineering Calculations

Disturbances to existing drainage systems will be minimized to the extent possible during the design of the surface facilities layout. Where disturbance of the existing drainage system cannot be avoided, both permanent and temporary channels are designed to replace the existing drainages. As shown in Figure 4, runoff from the main facilities area, which includes topsoil stockpiles, ore stockpiles, WRAs, and support facilities, will drain to the temporary drainage ditch, which leads to the temporary sedimentation basin. The sedimentation basin will discharge onto a tributary of the Creek. The permanent diversion channel captures runoff up gradient of the WRA in order to minimize potential surface water contamination from the site.

~~IUSA~~ **DUSA** plans for the mine to be a zero-discharge facility~~, and expects to~~ **DUSA has designed and** construct**ed** an evaporation pond of sufficient size to evaporate produced mine water through ~~all~~ the Phase I operation ~~phases~~. ~~IUSA~~ **DUSA** ~~plans to~~ **has** reconstruct**ed** a pond approximately within the footprint of the former Plateau Resources pond (Figure 5) to support Phase I operations. and ~~possibly~~ **DUSA plans to** expand its footprint if required for future project phases. Using historic and current information, a water balance was created to design the pond (Tetra Tech EMI 2006a). The groundwater permit-by-rule exception letter that has been submitted to UDEQ demonstrates that the pond will have no impact to groundwater quality, since all groundwater pumped to the surface will be detained in the pond until evaporated; and the groundwater quality of the mine will not exceed that of the background levels of groundwater quality.

Design calculations for the sizing of the temporary drainage ditch, temporary sedimentation basin, permanent diversion channel, and evaporation pond are included in the Surface Drainage Plan of the Tony M Mine and Reclamation Plan (Tetra Tech EMI 2006a).

Table 1 contains design characteristics for these drainage structures.

Table 1: Design Characteristics

Drainage Structures	Drainage (acres)	Storage (acre-feet)	Design Storm	Discharge Elevation (feet above MSL)
Temporary drainage ditch	17.8	NA	25-year, 6-hour	NA
Temporary sedimentation basin	17.8	0.74	25-year, 6-hour	4560
~~Permanent diversion channel~~	~~79.6~~	~~NA~~	~~100-year, 6-hour~~	~~4530~~

Evaporation pond	50.8	294.6	100-year, 6-hour	NA

2 INTRODUCTION

2.1 Stormwater Pollution Prevention Plan Requirements

This SWPPP was developed consistent with the requirements of the NPDES General Stormwater Permit for Construction Activities **and the Utah Division of Water Quality Multi-Sector General Permit (MSGP) for Stormwater Discharge Associated with Industrial Activities, Sector G Metal Mines (Ore Mining and Dressing). The Tony M Mine will be a zero discharge facility, all produced mine water will be diverted to the proposed evaporation pond and therefore will not be required to conduct analytical monitoring.** The SWPPP must be kept on site for use by ~~IUSA~~ **DUSA** and all contractors that create disturbances that may affect the quality of stormwater discharges. The Plan, properly implemented, should result in the discharge of water to the environment without the violation of Water Quality Standards.

2.2 Purpose

The purpose of this SWPPP is to:

- Describe best management practices (BMPs) to minimize erosion and sediment runoff at the site;
- Identify, reduce, eliminate, or prevent the pollution of stormwater; and
- Prevent violations of surface water quality or groundwater quality standards.

2.3 SWPPP Organization

This plan consists of a detailed narrative section and the appendices. The narrative section includes descriptions of potential pollution problems associated with site features, and then discusses the selection of specific pollution prevention BMPs to reduce or eliminate the threat of

causing pollution during the actual construction project. The figures show the site location and topography while Appendix C contains the BMP specifications and performance expectations.

The narrative section of this plan is organized in numbered sections around the 12 required elements of a SWPPP listed below:

1. Mark project clearing limits
2. Establishing the construction entrance(s)
3. Selection and installation of sediment controls
4. Stormwater detention
5. Soil stabilization
6. Slope protection
7. Drain inlet protection
8. Stormwater outlet protection
9. Materials handling and spill prevention
10. Stormwater treatment
11. BMP maintenance
12. Project management

In the narrative section, each of the above elements will be discussed in relation to the specific conditions at the mine site. BMPs for each element will be screened, resulting in selection of those BMPs deemed most appropriate for use. In addition, the final section discusses documentation for deviations from the plan.

3 CLEARING LIMITS

3.1 Site Plans

Figure 3 is the Topographic Base Map of the site showing all natural drainages associated with the area. Figure 4 shows the placement of all relevant stormwater BMPs, such as the temporary sedimentation basin and the drainage ditch.

3.2 Marking Clearing Limits

Prior to beginning earth-disturbing activities, including clearing and grading, all clearing limits, buffers, and drainage courses will be clearly marked to prevent environmental damage both on and off site.

3.3 Special Consideration

Special consideration will be given to the Creek's primary drainage channel and its tributaries throughout the project area. These drainage channels will be clearly demarcated and protected by BMPs.

3.4 Dust Control Measures

Dust control measures will be implemented during periods of high winds and must include, at a minimum, the application of water, $MgCl_2$, or $CaCl_2$, as appropriate, by means of trucks or hoses during clearing and grubbing of the site. (Material Safety Data Sheets [MSDS] for the chloride compounds are available in Appendix D.) Dust suppression should be controlled under all weather and operating conditions. All available and practical methods which are technologically feasible and economically reasonable should be used in order to minimize such emissions. All

loads leaving the site will be covered with a tarp in accordance with the requirements of the Utah Department of Transportation (UDOT).

The Utah Division of Air Quality determines air quality by the following methods (UDEQ 2006b).

- Opacity observations
- Records of production and dust mitigation efforts
- Facility records of emergency generator hours of operation
- Facility records of the sulphur content of the fuel used
- Compliance with the best available control technology (BACT)

Facility accordance with the emission rates specified under the new source performance standards and the national emission standards for hazardous air pollution (NESHAP)

During periods of high winds, water, $MgCl_2$, or $CaCl_2$ may be sprayed on wind-erosion prone soil areas to reduce wind erosion. Additionally, tackifier or rough-cut grading BMPs may be used to prevent wind erosion. The following methods are proposed for use at the Tony M Mine for dust control measures:

- Watering unpaved roads within the mine permit area and disturbed areas on an as-needed basis
- Vehicle speed control at a maximum of 25 miles per hour
- Revegetation of disturbed areas
- Grade furrows 1 foot at a right angle to the prevailing wind
- Compact disturbed soil to within 90 percent of the maximum compaction in foundation areas
- Silt fences for use as wind breaks
- Mulching or netting for steep slopes, if necessary

During mine operations, chemical stabilizers may be used at the discretion of ~~IUSA~~ **DUSA** to control dust generation. Revegetation of exposed soil areas and soil stockpiles should be completed as soon as practicable. Revegetated areas should be periodically inspected and

maintained as necessary. Revegetation methods are specified in the Tony M Mine and Reclamation Plan (Tetra Tech EMI 2006b).

3.5 Selected BMPs

The boundary of the site will be clearly marked. Cleaning and construction will remain within the boundaries of the project area.

- Silt Fences
- Vegetated Buffers
- Preserving Natural Vegetation
- Revegetation
- Permanent Mulching

4 CONSTRUCTION ACCESS

4.1 Site Access

The main access road to the mine is via six miles of an all-weather county road proceeding 1.5 miles west from Utah Highway 276 and then 4.5 miles north through ~~Shitamaring~~ **Shootamaring** Canyon. The Majority of the vehicles entering and exiting the site will be limited to this access. The access roads are stabilized with gravel roads.

4.2 Road Cleaning

If sediment is accidentally transported onto the county road it will be removed from the surface with a motor grader. The roads within the project area are covered with gravel; and, therefore, sediment transport by vehicles will be minimal.

4.3 Selected BMPs

- Construction Road/Parking Area Stabilization with Gravel

5 SEDIMENT CONTROLS

5.1 Site Sediment Control System

Site sediment control during mine operations will include an evaporation pond for mine dewatering and a temporary sedimentation basin below the main surface facilities area. BMPs may also include silt fences, straw bales, vegetated buffers, and diversion dikes. Figures 3, 4, and 5 delineate the existing drainage systems with the proposed drainage structures.

5.1.1 Evaporation Pond

An evaporation pond will be constructed and maintained. Figure 5 shows the evaporation pond area where mine water will be disposed and evaporated. Figures 2 and 3 show the access roads and ventilation shafts in the surrounding area. The facilities shown on these maps include:

- the main surface facilities area,
- the waterline corridor,
- the evaporation pond,
- the evaporation pond dam,
- the evaporation pond dike and emergency overflow spillway,
- the vent holes (existing and proposed), and
- the pond and vent hole access roads.

The groundwater being discharged from the mine will be conveyed in the waterline corridor, which is an enclosed pipe. This pipe then drains directly into the evaporation pond. The Tony M Mine is a zero-discharge facility; therefore, all groundwater discharged to the surface will be contained within the pond where evaporation will occur. The pond is designed to detain all discharged water from the underground mine as well as runoff from the surrounding area produced from the 100-year, 6-hour storm event.

5.1.2 Temporary Sedimentation Basin

The temporary sedimentation basin will be constructed within the temporary drainage ditch, upstream of where the temporary drainage ditch flows into a natural drainage channel south of the mine site (see Figure 5). Runoff from the main surface facilities area will flow from the temporary drainage ditch to this feature, where sedimentation will occur. Both the ditch and the sedimentation basin are designed for the 25-year, 6-hour storm event.

5.1.3 Vegetated Buffers

Vegetated buffers will be placed between the Creek and the support facilities. These vegetated buffers will provide erosion control, stormwater detention, and biofiltration during and after construction and mining activities.

5.2 Post Construction Stormwater Management Measures

During mine reclamation, the temporary drainage structures will be backfilled and reclaimed and the natural drainage system will be restored. Permanent BMPs will be used to prevent sediment and contaminated runoff from discharging from the site. Examples of these types of BMPs include the permanent diversion channel above the WRA and revegetation of disturbed areas. The design characteristics of the permanent diversion channel are further explained in the Surface Drainage Plan (Tetra Tech EMI 2006a).

5.3 Selected BMPs

- Silt Fences
- Temporary Sedimentation Basin
- Temporary Drainage Ditch
- Permanent Diversion Channel
- Evaporation Pond
- Rough-Cut Grading
- Revegetation
- Permanent Mulching

- Check Dams
- Earth Dikes
- Drainage Swales
- Stockpile Seeding

6 STORMWATER DETENTION

6.1 Primary Stormwater Detention System

Since the Tony M Mine is a proposed zero-discharge facility, the stormwater detention system is critical to the prevention of stormwater pollution. Stormwater generated from the disturbed areas will be diverted to two locations, the temporary sedimentation basin and the evaporation pond (Figures 4 and 5). The sedimentation basin detains overland flow from the main portal area, which includes surface facilities. The evaporation pond contains the discharges from the mine dewatering process as well as overland flow from higher elevations in the surrounding area. The evaporation pond has been designed to detain discharges from the up gradient watershed generated from the 100-year, 6-hour storm event. The temporary sedimentation basin is designed for the 25-year, 6-hour storm event. If an event greater than the 25-year storm occurs, stormwater will drain into a tributary to the Creek, which eventually drains into the Upper Lake Powell watershed of the Colorado River.

The temporary sedimentation basin is designed with the following properties:

- Drainage area to the sedimentation basin equals 17.8 acres of on-site property.
- Total basin storage volume equals 0.74 acre-feet.

Water quality flows will discharge from the catchment basin via the temporary drainage ditch. During an event greater than the 25-year, 6-hour storm event, the outlet structure will discharge flow at a water surface elevation of 4,560 feet above mean sea level.

The evaporation pond is designed with the following properties:

- Drainage area to the evaporation pond equals 50.8 acres of on-site property.
- Total pond storage volume equals 294.6 acre-feet at a maximum elevation of 4,874 feet above mean sea level.

- The outlet structure on the south dike provides for emergency overflow at an elevation of 4,876 feet above mean sea level.

The temporary drainage ditch and any other water conveyances draining active construction areas to the temporary sedimentation basin will be stabilized with vegetation, rock, matting, or other suitable methods. Check dams will be placed as needed to reduce water velocities and settle out sediment prior to entering the temporary sedimentation basin. Additional temporary sedimentation basins may also be installed as needed to further reduce sediment loads in water draining from construction areas.

6.2 Permanent Diversion Channel

The stormwater generated from the upgradient, undisturbed western portion of the site will be diverted around the disturbed area via a permanent diversion channel. This water will be routinely monitored to ensure only clean water is discharged to the stream. If the water becomes contaminated, a sedimentation basin will be installed upstream of its outlet.

6.3 Selected BMPs

See the Surface Drainage Plan of the Tony M Mine and Reclamation Plan (Tetra Tech EMI 2006a) for further detail.

- Check Dams
- Earth Dikes
- Drainage Swales

6.4 Post Construction Stormwater Management Measures

After construction is completed, permanent BMPs will be used to prevent sediment and contaminated runoff from discharging from the site. Examples of these types of permanent BMPs include a diversion channel and revegetation of disturbed areas, as previously specified in Section 5.3.

7 SOIL STABILIZATION

This section describes the stabilization and structural BMPs that will be implemented to minimize erosion and transport of sediment from the project site into receiving waters.

Incremental impacts to soil and plant resources will be minimal, as approximately 97 percent of the proposed disturbed area occurs on previously disturbed or reclaimed land.

Soil and plant mitigation measures will include salvaging the available topsoil and any suitable subsoil material prior to disturbing an area. Erosion and sediment control measures will be implemented to minimize loss of soil resources. Vegetation resources will be mitigated by seeding topsoil stockpiles and any reclaimed areas during the fall planting season. During reclamation, the constructed slopes of the WRA will be regraded to achieve final slopes of 3H:1V or less steep. The dam will be left in a non-impounding condition. Upon mine closure, the entire disturbed area will be revegetated.

7.1 Soil Stabilization

Stabilization BMPs to be implemented at this site include:

- **Preserving Natural Vegetation.** Existing and new vegetation will be maintained to the maximum extent practicable to prevent the contamination of stormwater with sediment. Vehicles and equipment travel will be limited to existing roads and the mine disturbed area specified in the Tony M Mine and Reclamation Plan (2006b).
- **Revegetation.** Disturbed areas that are not needed to support active mining operations will be regraded and seeded with the approved seed mix in the fall.
- **Stockpile Seeding.** Long-term topsoil stockpiles will be seeded in the fall. Silt fence will be installed around the stockpiles, if necessary, to minimize soil loss.

- **Outlet Protection.** Adequate energy dissipation, erosion control, and soil stabilization measures (e.g., rock or other energy dissipation techniques) will be provided for all point source discharges of stormwater, including run-on discharges and outlets from onsite discharges.

7.2 Structural BMPs

Structural BMPs are practices designed to divert flows from exposed soil, store stormwater runoff, and limit runoff and the discharge of pollutants from exposed areas of the project. The goal of structural BMPs on this project is to protect receiving water downstream of the site from turbid water, sediment, oil, and other contaminants, which may mobilize in stormwater flows.

- **Silt Fences.** A portion of the stormwater generated by sheet flow on-site during construction will not discharge to the on-site temporary sedimentation or permanent ponds. Silt fences can be installed to capture sediment in stormwater that flows across the construction boundary to ensure that sediment is not carried off of the site.

- **Sedimentation Swales and Ponds.** Temporary and permanent swales and small detention ponds can be used as necessary to reduce the velocity of runoff and enhance particle settling.

- **Earth Dikes.** During site construction, stormwater runoff from up gradient, off-site locations can encroach on the site and increase on-site erosion. On-site erosion during construction can be greatly decreased when off-site flows, not disturbed by mining activities, are diverted around the site. A temporary diversion dike can consist of an earthen wall and a temporary drainage swale along the upstream boundary of the site that diverts off-site stormwater around the construction area. The diversion dike is designed to ensure that the off-site stormwater will reconnect with its original flow path downstream of the site and upstream of the waterway. Diversion dikes may also be used to ensure that on-site runoff will discharge to the on-site temporary sedimentation pond and will not discharge from the site.

- **Drainage Swales, Ditches, and Check Dams.** Swales and ditches may be used on a permanent and temporary basis to convey stormwater in a way that minimizes the

potential for contamination by sediment. Because some sediment will always be present in stormwater, check dams can be used in swales and ditches to reduce the velocity of the water and allow some settling of larger particles.

- **Outlet Protection.** Stormwater that discharges from a temporary sedimentation basin can be conveyed to the receiving waters as surface flow. The velocity of the water may be erosive as it discharges to receiving waters. Erosion control at the outlet of conveyance structures can consist of riprap or other approved slope erosion protection.

7.3 Selected BMPs

- Silt Fences
- Drainage Ditches
- Sedimentation Swales and Ponds
- Preserving Natural Vegetation
- Revegetation
- Check Dams
- Earth Dikes
- Drainage Swales
- Stockpile Seeding
- Outlet Protection

8 SLOPE PROTECTION

8.1 General Practices

Cut and fill slopes on this project have been designed and will be constructed so as to minimize erosion. Soil types have been analyzed and considered for their potential to erode. In addition, slope runoff velocities will be reduced by terracing, creating diversions, and surface contouring.

Upslope drainage and uncontaminated run-on water from off-site will be intercepted at the top of the slope and diverted around the active construction area and active mine area. Down slope flows will be contained in stabilized ditches.

8.2 Reclamation Practices

Project reclamation will include regarding of the steeper slopes to achieve long-term stable slopes. The slopes will then be covered with topsoil, contour ripped, and seeded to create a vegetative cover that minimizes erosion.

8.3 Suggested BMPs

The BMPs used during construction are listed below.

- Check Dams
- Earth Dikes
- Drainage Swales
- Gradient Terraces
- Grass-Lined Channels and Ditches

The BMPs implemented during reclamation are the following:

- Slope Reduction
- Topsoil Placement
- Contour Ripping
- Revegetation

9 DRAIN INLET PROTECTION

Drain inlet protection is applicable to the upstream ends of culverts, which will be protected with riprap as needed. Existing storm drains are not present at the site.

9.1 Existing Storm Drains

No existing storm drain inlets are located within the area of construction. On-site BMPs, such as temporary sedimentation ponds and silt fences, will be used to control and reduce erosion and sedimentation on the site.

9.2 Newly Constructed Storm Drains

Inlets to culverts used to convey flow will be protected with riprap as necessary. This will particularly apply to the culvert used to convey flow in the temporary drainage ditch to the east side of the county road.

9.3 Suggested BMPs

- Silt Fences
- Riprap
- Filter Fabric Inlet Protection
- Excavated Gravel Inlet Protection
- Block and Gravel Inlet Protection

10 STORMWATER OUTLET PROTECTION

10.1 Evaporation Pond and Sedimentation Basin Outlets to Stream

The sedimentation basin will discharge water to tributaries of the Shitamaring Creek during storm events exceeding its design storm. At the point where discharge enters the stream, outlet protection will be provided using riprap channel lining or other armoring material to prevent erosion of the streambank. The culvert used to convey flow in the temporary drainage ditch to the east side of the county road, as well as outfalls of this drainage ditch into the tributary to the south of the site, will also be armored with riprap.

10.2 Road Drainage to Stream

At the point where road runoff enters the stream, outlet protection will be provided using riprap channel lining or other armoring material to prevent erosion of the streambank.

10.3 Permanent Drainage to Stream

Stormwater from the permanent diversion channel will discharged to the unnamed tributary south of the mine site and ultimately to the Creek. At the point where bypass runoff enters the receiving water, outlet protection will be provided using riprap channel lining or other armoring material to prevent erosion of the streambank.

10.4 Suggested BMPs

- Riprap
- Outlet Protection

11 MATERIALS HANDLING AND SPILL PREVENTION

Consistent with the general permit requirements, all potential pollutants other than sediment will be handled and disposed of in a manner that does not cause contamination of stormwater.

~~IUSA~~ **DUSA** plans to ship any solid waste from surface operations to appropriately permitted off-site disposal facilities. ~~IUSA~~ **DUSA** does not plan to construct any on-site solid waste disposal units. ~~IUSA~~ **DUSA** plans to rehabilitate an existing sanitary leach field for sanitary wastes from the change house and other surface buildings.

Materials management and spill prevention techniques are essential to prevent pollution of receiving drainages defined by the CWA as waters of the United States. Once pollution prevention measures are implemented, ~~IUSA~~ **DUSA** is responsible to maintain good housekeeping practices on the construction site. This section discusses the specific BMPs that are most critical to prevent discharge of stormwater pollutants to receiving waters. Specification sheets for specific BMPs are provided in Appendix C to aid ~~IUSA~~ **DUSA** in implementing and maintaining these practices. Emergency contacts for the project will be posted at the project office and are in Appendix E. In the event of a spill, a spill report form should be completed (Appendix F). Non-sediment pollutants that may be present during mining or construction activities include:

- Petroleum products including fuel, oils, lubricants, and hydraulic fluids
- Concrete
- Paints
- $MgCl_2$ and $CaCl_2$

These materials, and other materials used during construction with the potential to impact stormwater, will be stored, managed, used, and disposed of in a manner that minimizes the potential for releases to the environment and especially into stormwater.

11.1 General Materials Handling Practices

The following general practices will be used throughout the project to reduce the potential for spills.

- Potential pollutants will be stored and used in a manner consistent with the manufacturer's instructions in a secure location. To the extent practicable, material storage areas should not be located near drainages or storm drain inlets and should be equipped with covers, roofs, or secondary containment as needed to prevent stormwater from contacting stored materials. Chemicals that are not compatible shall be stored in segregated areas so that spilled materials cannot combine and react.

- Materials disposal will be in accordance with the manufacturer's instructions and applicable local, state, and federal regulations.

- Materials no longer required for construction or mining will be removed from the site as soon as practicable.

- Adequate garbage, construction waste, and sanitary waste handling and disposal facilities will be provided to the extent necessary to keep the site clear of obstruction and BMPs clear and functional.

11.2 Specific Materials Handling Practices

- All pollutants, including waste materials and demolition debris, that occur on-site during construction and mining activities will be handled in a way that does not contaminate stormwater.

- All chemicals including liquid products, petroleum products, water treatment chemicals, and wastes stored on site will be covered, contained, and protected from vandalism.

- Maintenance and repair of all equipment and vehicles involving oil changes, hydraulic system drain down, de-greasing operations, fuel tank drain down and removal, and other activities which may result in the accidental release of contaminants, will be conducted in the shop or underground maintenance area. If repairs need to be conducted

outside of the shop, measures will be taken to contain all potential contaminants. Materials spilled during maintenance operations will be cleaned up immediately and properly disposed of.

- Application of magnesium chloride and calcium chloride will be conducted in a manner and at application rates that will not result in an excessive loss of chemical to stormwater runoff. Manufacturers' recommendations will be followed for application rates and procedures.

- pH-modifying sources will be managed to prevent contamination of runoff and stormwater collected on site. The most common sources of pH-modifying materials are bulk cement, cement kiln dust (CKD), fly ash, new concrete washing and curing waters, waste streams generated from concrete grinding and sawing, exposed aggregate processes, and concrete pumping and mixer washout waters.

11.3 Spill Response

The primary objective in responding to a spill is to quickly contain the material(s) and prevent or minimize their migration into stormwater runoff and conveyance systems. If the release has impacted on-site stormwater, it is critical to contain the released materials on site and prevent their release into receiving waters.

If a spill of pollutants threatens stormwater at the site, the spill response procedures outlined below must be implemented in a timely manner to prevent the release of pollutants.

- The ~~Mine General Superintendent~~ **Mine Compliance Technician** will be notified immediately when a spill, or the threat of a spill, is observed. The ~~superintendent~~ **Mine Compliance Technician** will assess the situation and determine the appropriate response.

- If spills represent an imminent threat of escaping erosion sediment control (ESC) facilities and entering the receiving waters, facility personnel will respond immediately to contain the release and notify the superintendent after the situation has been stabilized.

- Spill kits containing materials and equipment for spill response and cleanup will be maintained at the site. Recommended spill kit contents include:
  - Oil absorbent pads (one bale)
  - Oil absorbent booms (40 feet)
  - 55-gallon drums (2)
  - 9-mil plastic bags (10)
  - Personal protective equipment including gloves and goggles
- If an oil sheen is observed on surface water (e.g., temporary sedimentation basin, evaporation pond, ditches, and channels), absorbent pads and/or booms will be applied to contain and remove the oil. The source of the oil sheen will also be identified and removed or repaired as necessary to prevent further releases.
- The ~~site superintendent~~ **Mine Compliance Technician**, or his designee, will be responsible for completing the spill reporting form and for reporting the spill to the appropriate state or local agency.
- Facility personnel with primary responsibility for spill response and cleanup will receive training from the site superintendent. This training will include identifying the location of spill kits and other spill response equipment and the use of spill response materials.
- Spill response equipment will be inspected and maintained as necessary to replace any materials used in spill response activities.

11.4 Notification

In the event of a spill, make the appropriate notification(s) consistent with the following procedures:

- Any spill of oil which 1) violates water quality standards, 2) produces a "sheen" on a surface water, or 3) causes a sludge or emulsion must be reported immediately by telephone to the National Response Center Hotline at (800) 424-8802.

- Any spill of oil or hazardous substance to waters of the state must be reported immediately by telephone to the Division of Water Quality at (801) 538-6146 during regular business hours or to the UDEQ at (801) 536-4123 after regular business hours.

- Any 25-gallon-or-greater release of a hazardous substance that may be a threat to human health or the environment must be reported to the UDEQ at (801) 536-4123 immediately upon discovery (UDEQ 2006c).

12 STORMWATER TREATMENT

12.1 Stormwater Collection System

During all phases of construction and grading, ~~IUSA~~ **DUSA** will provide stormwater collection and conveyance systems to collect and direct sediment contaminated water to temporary sediment traps as needed to prevent offsite discharge of sediment laden stormwater. Construction and mining activities will occur in phases as much as practicable to avoid unnecessarily disturbing vegetated areas of the site. Clean stormwater, generated from stabilized and undisturbed portions of the site, will be collected and conveyed to stabilize discharge areas whenever necessary to avoid contact with disturbed portions of the site. All conveyance and collection systems will be constructed consistent with State and local BMP requirements.

12.2 Temporary Sedimentation Basin

During construction and mining, sediment contaminated stormwater will be conveyed to the temporary sedimentation basin, shown on the Surface Drainage Plan of the Tony M Mine and Reclamation Plan (Tetra Tech EMI 2006a). The sedimentation basin will gravity-settle large particles down to silt size particles. Considering subsurface soil types, it is unlikely that gravity settling alone will remove all suspended particles.

13 BMP MAINTENANCE

All temporary and permanent erosion and sediment control BMPs will be maintained and repaired as needed to assure continued performance of their intended function. All maintenance and repair will be conducted in accordance with BMPs. Recommended BMP standards and specifications are in Appendix B; and the BMP inspection form is included in Appendix G.

All temporary erosion and sediment control BMPs will be removed after final site stabilization is achieved or after the temporary BMPs are no longer needed. Trapped sediment will be removed or stabilized on site. Disturbed soil areas resulting from removal of BMPs or vegetation will be permanently stabilized as soon as possible.

During mining operations, ~~IUSA~~ **DUSA** will be responsible for maintenance of all temporary and permanent BMPs at the site. This maintenance includes dredging and cleaning out detention basin outlets and outfalls, repairing and cleaning ditches and culverts, repairing or reinstalling silt fence where needed, and keeping the general property free of trash.

13.1 Inspections

Regular inspections document compliance with EPA regulations. The intent of the construction stormwater permit is to protect receiving streams from sedimentation and other potential pollutants during construction and facility operation.

~~IUSA~~ **DUSA** is responsible for ensuring that adequate and compliant inspections of the erosion control, materials management, and spill prevention BMPs are installed as specified and are in accordance with the plans and specifications. This documentation can consist of, and conform to, the Inspection Form provided as Appendix G or comparable method. Documentation of these inspections must be kept with this SWPPP. The contractor should thoroughly inspect the stormwater management system. The EPA requires inspections of construction activities every 14 days and after any precipitation or snowmelt event that causes surface erosion for the duration of construction and until all disturbed areas are stabilized.

In addition to inspections, follow-up maintenance must occur and be adequately documented in the inspection checklist. Follow-up maintenance includes repairing BMPs that have been damaged by everyday construction, stormwater runoff, or wind erosion. Maintenance may require replacement or addition of BMPs in areas where high erosion or sedimentation is occurring.

13.2 Preventative Maintenance

~~IUSA~~ **DUSA** will institute a preventative maintenance program that includes the following:

Identification of sediment and erosion controls, equipment, and site areas with high pollution potential (chemical or equipment storage and washing areas) that should be inspected on a regular basis.

Appropriate and timely maintenance, repair, or replacement of control measures and equipment.

Preparation of thorough records for inspections of equipment and systems.

~~IUSA~~ **DUSA** will maintain a logbook or recordkeeping system of construction with respect to the SWPPP. The following list of activities and information should be recorded in a SWPPP logbook:

- A record of spills, leaks, or overflows, including time and date, weather conditions, and related factors
- Implementation of specific items in the SWPPP and erosion control plan
- Training events (given or attended)
- Events involving material storage and handling
- Contacts with regulatory agencies and personnel
- Notes of employee activities, contacts, and notifications
- Maintenance and repair of stormwater management controls
- Preventative maintenance
- Inspections

Additional information, such as dated photographs, field notebooks, and figures, should be included where appropriate. ~~IUSA~~ **DUSA** is responsible for informing any subcontractors of this plan and ensure implementation and compliance. Appendix G provides an example inspection form for documentation purposes. Appendix H provides a training signature sheet for recordkeeping purposes. Photographs are useful for documenting the condition and maintenance of BMPs by the contractor. Appendix I provides

envelopes for maintaining a photo log and complements the field inspection checklist. Appendix J provides note pages for additional notes and record keeping.

14 PROJECT MANAGEMENT

Implementation and management of the environmental aspects of this project under the SWPPP are the responsibilities of ~~IUSA~~ **DUSA** and its subcontractors. Communication between all parties performing work on the site is essential for proper implementation of the SWPPP. ~~Jim Fisher~~ **Danny Flannery**, the Tony M Mine ~~General Superintendent~~ **Compliance Technician**, should be familiar with the SWPPP and the responsibilities under the plan. To help delegate these responsibilities the following outline has been provided:

14.1 Phasing of Construction

The project has been planned at this point in three phases to reduce the environmental impact. Phase one will result in the development of the southern portion of the mine. During this time, the Phase II and III areas, will remain undisturbed with existing vegetative cover. The tentative construction schedule for Phase I is in Appendix B. This SWPPP is only intended to cover Phase I of mine construction and operations.

14.2 Seasonal Work

The stormwater drainage system has been designed to allow for work on the project during the winter months without impacting off-site water quality. While not seasonal, some construction activities may need to be postponed if scheduled during ongoing storm events.

14.3 Training

~~IUSA~~ **DUSA** will provide onsite training to key personnel responsible for compliance with the SWPPP. ~~Jim Fisher~~ **Danny Flannery**, the Tony M Mine ~~General Superintendent~~ **Compliance Technician**, will be familiar with the major elements of the plan. Construction workers and others at the site will be given appropriate training information at the conclusion of site safety meetings or on an as-needed basis.

14.4 Pre-construction Conference

One or more pre-construction meetings will be held with an explicit agenda item addressing the SWPPP.

14.5 Coordination with Utilities and other Contractors

All contractors providing services on the project which may cause stormwater pollution will be provided with the SWPPP location and provided with appropriate training regarding stormwater pollution prevention.

14.6 Subcontractor Oversight

Subcontractor oversight to ensure compliance with the SWPPP will be provided by the Mine ~~General Superintendent~~ **Compliance Technician**. Informal, on-the-job tailgate training will be the first level of communication followed by onsite observation of training compliance. Non-compliance with SWPPP policies will trigger a more intensive training session to correct the problem(s). Chronic non-compliance with SWPPP policies may require the intervention of local and/or state regulatory personnel.

14.7 Monitoring/Reporting

Reports, such as erosion and sediment control inspections, will be the responsibility of ~~IUSA~~ **DUSA**. Spill reports will be completed and submitted by ~~IUSA~~ **DUSA**.

14.8 SWPPP Update

The SWPPP will be updated as necessary to address changes in the Mine and Reclamation Plan.

15 DEVIATIONS FROM THE PLAN

All major deviations from this SWPPP must be documented and provided with the Plan. Deviations generally involve implementation of BMPs that are different from the plans and specifications or details provided in the BMP specification sheets in Appendix C. Any deviations in BMPs should also be documented in legible writing and in ink on an erosion control map Deviations may include relocation or addition of erosion control structures such as rough-cut grading, outlet protection, or temporary sedimentation ponds. Additional temporary sedimentation ponds may need to be added at the contractor's discretion to prevent high sediment loads from entering receiving waters of the state and would be deemed a deviation of the plan. ~~IUSA~~ **DUSA** may also choose to implement a different form of BMP, such as a straw wattle or straw bales, instead of silt fences. These types of changes will need to be documented and added to the Plan.

Appendix K contains a template form that can be used to document any deviations from this plan. These forms can be completed at the construction site by the Mine ~~General Superintendent~~ **Compliance Technician** or after regularly scheduled inspections. The deviations need not be typed or formal; hand-written legible notes are sufficient. These forms, along with changes to the Mine Plan as shown in Figures 4 and 5, can be included with deviations in the Appendices and incorporated into the plan to document changes to the SWPPP to comply with these recording procedures.

16 REFERENCES

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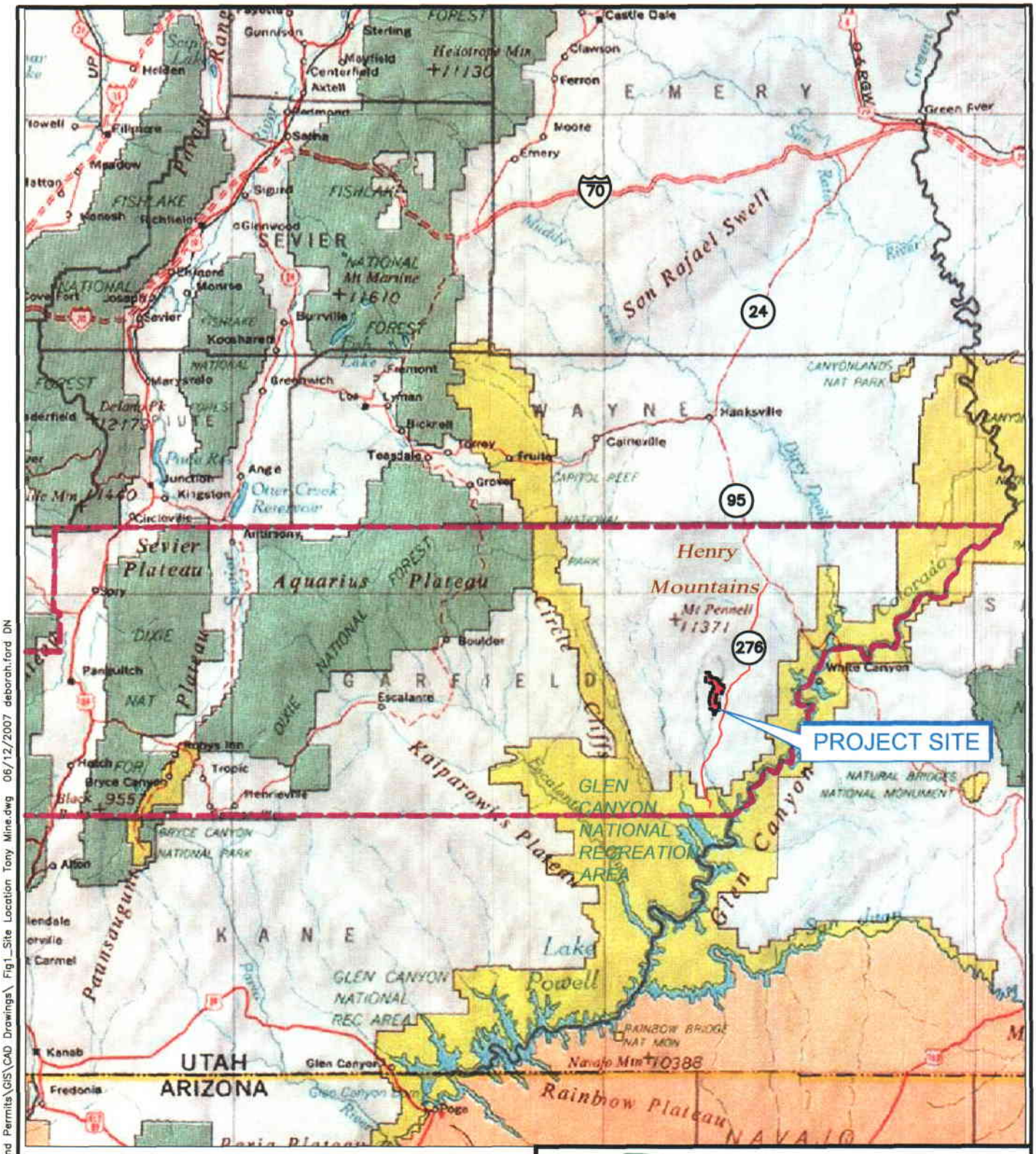
FIGURES



LEGEND

APPROXIMATE SITE BOUNDARY

GARFIELD COUNTY BOUNDARY

10 0 10 20

SCALE: 1" = 20 MILES

DENISONMINES

Project	TONY M. MINE				
County: Garfield	State: Utah	Location: T 34-35 S, R 11 E			
DSGN: FJF	DRN: DMF	DATE: 06/12/2007	REVISION:		

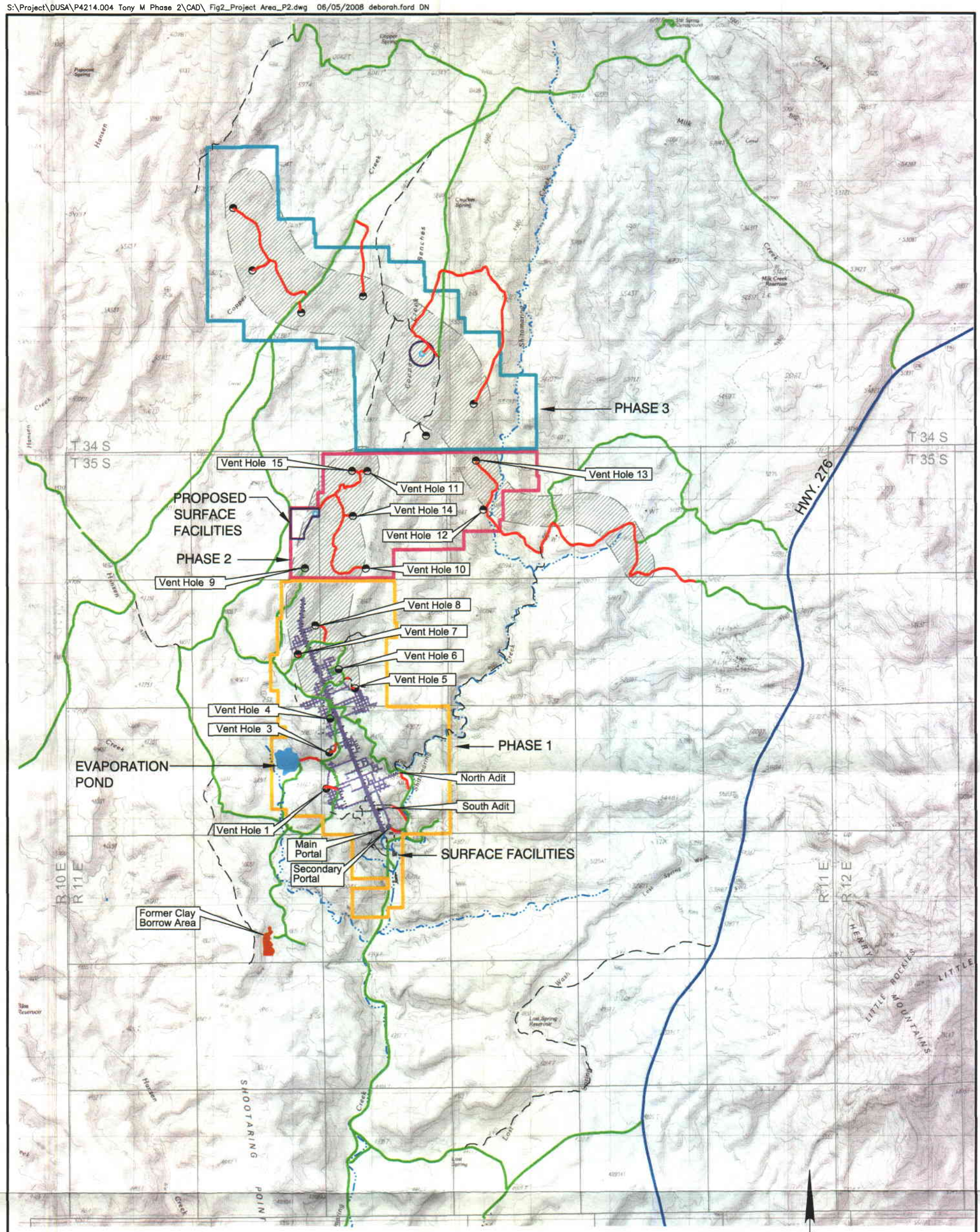
FIGURE 1
PROJECT LOCATION MAP

TETRA TECH EM INC.

RECEIVED
JUN 06 2008
DIV. OF OIL, GAS & MINING

S:\Project\USA\T05 Tony M Bullfrog Plans and Permits\GIS\CAD Drawings\ Fig1_Site Location Tony Mine.dwg 06/12/2007 deborah.ford DN

S:\Project\DUSA\P4214.004 Tony M Phase 2\CAD\ Fig2_Project Area_P2.dwg 06/05/2008 deborah.ford DN



LEGEND

- PROPOSED VENT HOLES
- EXISTING VENT HOLES
- PROPOSED PRODUCTION SHAFTS
- ORE DEPOSIT
- EXISTING UNDERGROUND WORKINGS
- NEW OR RECONSTRUCTED ROADS
- EXISTING ROADS
- EXISTING 4X4 ROADS
- HIGHWAY 276
- PHASE 1
- PHASE 2
- PHASE 3

DENISON MINES

Project	TONY M. MINE		
County: Garfield	State: Utah	Location: T 34-35 S, R 11 E	
DSGN: FJF	DRN: DMF	DATE: 06/02/2008	REVISION: 3

FIGURE 2
PROJECT AREA MAP

TETRA TECH

VH-9
VH-10
VH-8
VH-7
VH-6
VH-5
VH-4
VH-3
VH-1
Waterline Corridor
Underground Water Boundary
Proposed Evaporation Pond
Dam
Utah State Lease Stockpile
Portal Area Surface Facilities See Figure 5
Non-Denison Owned Stockpile
Shitamaring
5, 4, 3, 8, 9, 10, 17, 16, 15, 20, 21, 22
4895T
5186T
5058T
4961T
5082T
5116T
5011T
5091T
4848T
4808AT
5004T
4835T
4860T
4398T
4740T
4891T
5070T
5068T
Adits
4WD

Legend

- Existing Vent Hole
- Proposed Vent Hole
- Existing Road
- Reconstructed Road
- Proposed Road
- Existing 4-Wheel Drive Road
- Phase 1 Boundary
- Phase 2 Boundary
- Ephemeral Drainage
- Underground Workings
- Section Line

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DIV. OF OIL, GAS & MINING

N

1,000 0 1,000 Feet

DENISON MINES

Project: TONY M. MINE			
County: Garfield	State: Utah	Location: T 34-35 S, R11 E	
DSGN: CW	DRN: KDC	Date: 05/13/2008	Revision: 2

FIGURE 3
TOPOGRAPHIC BASE MAP

TETRA TECH

S:\Project\DUSA\P4214.004 Tony M Phase 2\GIS\mxd\Figures\NOI\Fig3_topo14400.mxd TtEMI Kurt. Cholak

Utah State Lease Stockpile
Water Tank
Toplander Building
Ore Slots
Main Portals
Hard Basin Drop
Gate
OSA
Section 16
Section 21
WRA
Permanent Diversion Channel
Compressor
Pump House
Generator
Laydown Area
TS
Fueling Station
Temporary Drainage Channel
Maintenance Shop
Parking
Office/Dry
Septic Tanks
Leach Field
Temporary Sediment Basin
4750
4700
4600
4550
4500
4650
4450
4800
5
4
3
8
9
10
17
16
15
20
21
22

Legend

- Surface Disturbance Boundary
- Constructed Channel
- Existing Drainage
- Culvert
- Site Road
- Fence
- TS Topsoil Stockpile Area
- OSA Ore Stockpile Area
- WRA Waste Rock Area
- Hard Basin
- Building
- Utah State Lease Stockpile
- Sediment Basin
- Underground Workings
- Phase 1 Boundary
- Section Line

Groundsurface Contours

- 10-ft Contour
- 50-ft Contour

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0 200 Feet

DENISON MINES

Project:	TONY M. MINE		
County: Garfield	State: Utah	Location: T. 35S , R. 11E	
DSGN: CW	DRN: KDC	Date: 05/13/2008	Revision: 2

FIGURE 4
Portal Area Detail Map

TETRA TECH

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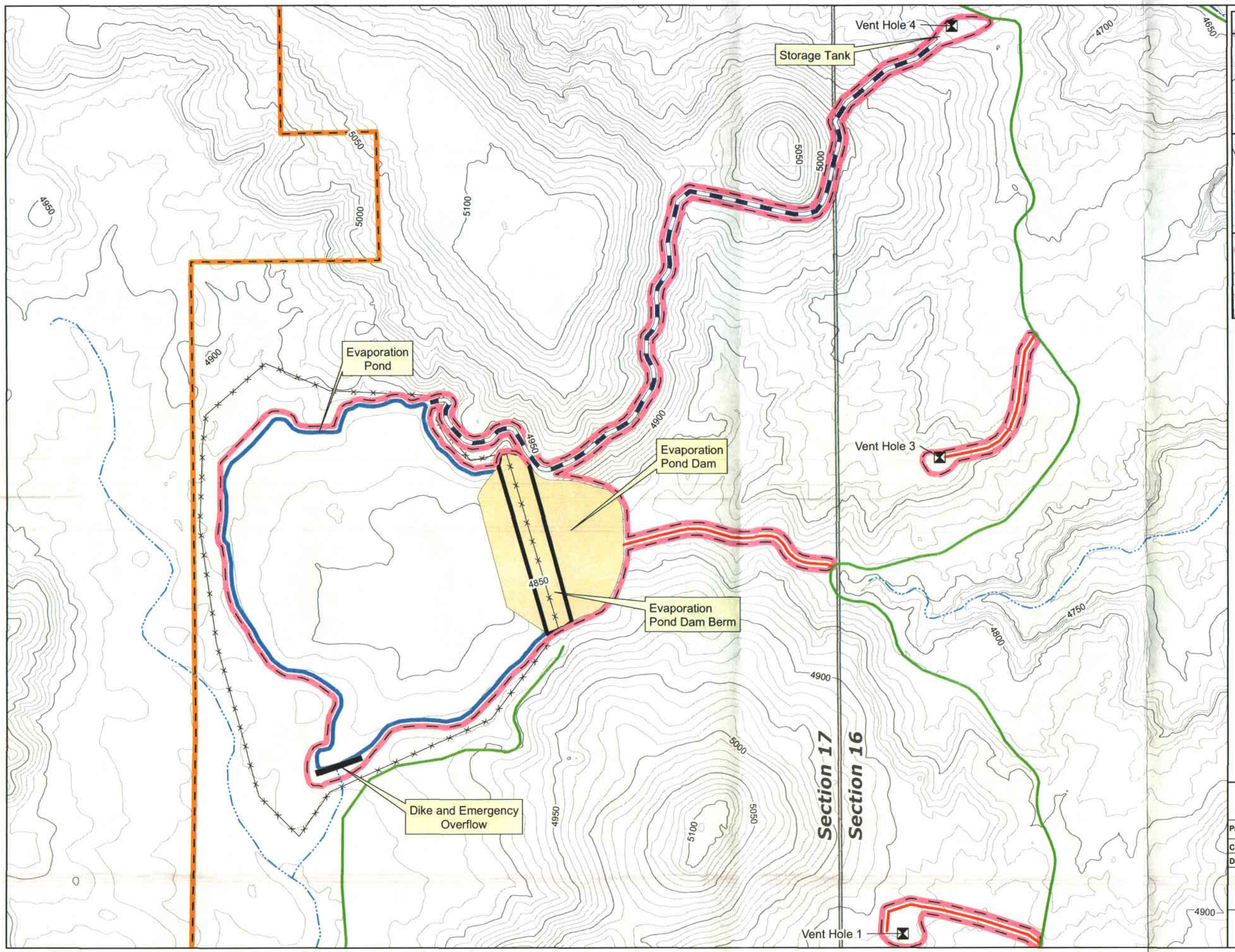

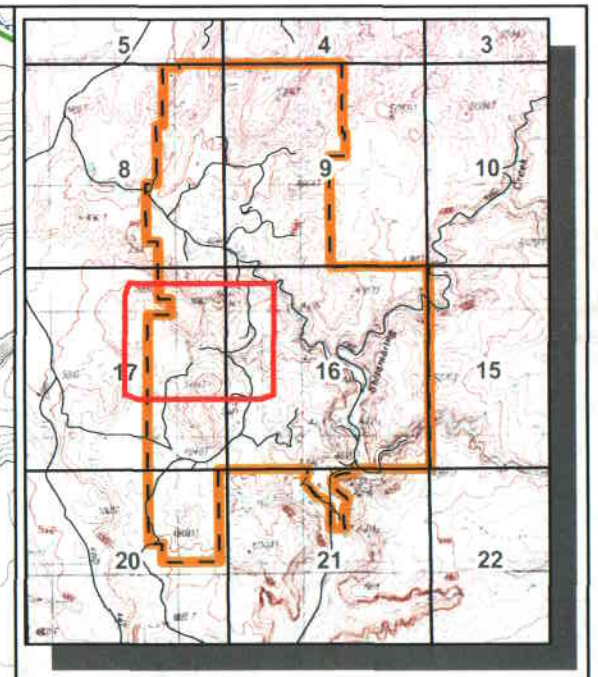

Legend

- Vent Hole
- Waterline Corridor
- Existing Road
- Reconstructed Road
- Ephemeral Drainage
- Phase 1 Boundary
- Surface Disturbance Boundary
- Fence

Groundsurface Contours

- 10-ft Contour
- 50-ft Contour
- Section Line

N

300 0 300

Feet

DENISON MINES

Project: TONY M. MINE			
County: Garfield	State: Utah	Location: T. 35S, R. 11 E	
DSGN: CW	DRN: KDC	Date: 05/30/2008	Revision: 2

FIGURE 5
Evaporation Pond Detail Map

TETRA TECH

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APPENDIX A

STATE WATER QUALITY STANDARDS

R317. Environmental Quality, Water Quality.
R317-2. Standards of Quality for Waters of the State.
R317-2-1A. Statement of Intent.

Whereas the pollution of the waters of this state constitute a menace to public health and welfare, creates public nuisances, is harmful to wildlife, fish and aquatic life, and impairs domestic, agricultural, industrial, recreational and other legitimate beneficial uses of water, and whereas such pollution is contrary to the best interests of the state and its policy for the conservation of the water resources of the state, it is hereby declared to be the public policy of this state to conserve the waters of the state and to protect, maintain and improve the quality thereof for public water supplies, for the propagation of wildlife, fish and aquatic life, and for domestic, agricultural, industrial, recreational and other legitimate beneficial uses; to provide that no waste be discharged into any waters of the state without first being given the degree of treatment necessary to protect the legitimate beneficial uses of such waters; to provide for the prevention, abatement and control of new or existing water pollution; to place first in priority those control measures directed toward elimination of pollution which creates hazards to the public health; to insure due consideration of financial problems imposed on water polluters through pursuit of these objectives; and to cooperate with other agencies of the state, agencies of other states and the federal government in carrying out these objectives.

R317-2-1B. Authority.

These standards are promulgated pursuant to Sections 19-5-104 and 19-5-110.

R317-2-2. Scope.

These standards shall apply to all waters of the state and shall be assigned to specific waters through the classification procedures prescribed by Sections 19-5-104(5) and 19-5-110 and R317-2-6.

R317-2-3. Antidegradation Policy.

3.1 Maintenance of Water Quality

Waters whose existing quality is better than the established standards for the designated uses will be maintained at high quality unless it is determined by the Board, after appropriate intergovernmental coordination and public participation in concert with the Utah continuing planning process, allowing lower water quality is necessary to accommodate important economic or social development in the area in which the waters are located. However, existing instream water uses shall be maintained and protected. No water quality degradation is allowable which would interfere with or become injurious to existing instream water uses.

In those cases where potential water quality impairment associated with a thermal discharge is involved, the antidegradation policy and implementing method shall be consistent with Section 316 of the Federal Clean Water Act.

3.2 High Quality Waters - Category 1

Waters of high quality which have been determined by the Board to be of exceptional recreational or ecological significance or have been determined to be a State or National resource requiring protection, shall be maintained at existing high quality through designation, by the Board after public hearing, as High Quality Waters - Category 1. New point source discharges of wastewater, treated or otherwise, are prohibited in such segments after the effective date of designation. Protection of such segments from pathogens in diffuse, underground sources is covered in R317-5 and R317-7 and the Regulations for Individual Wastewater Disposal Systems (R317-501 through R317-515). Other diffuse sources (nonpoint sources) of wastes shall be controlled to the extent feasible through implementation of best management practices or regulatory programs.

Projects such as, but not limited to, construction of dams or roads will be considered where pollution will result only during the actual construction activity, and where best management practices will be employed to minimize pollution effects.

Waters of the state designated as High Quality Waters - Category 1 are listed in R317-2-12.1.

3.3 High Quality Waters - Category 2

High Quality Waters - Category 2 are designated surface water segments which are treated as High Quality Waters - Category 1 except that a point source discharge may be permitted provided that the discharge does not degrade existing water quality. Waters of the state designated as High Quality Waters - Category 2 are listed in R317-2-12.2.

3.4 For all other waters of the state, point source discharges are allowed and degradation may occur, pursuant to the conditions and review procedures outlined below:

a. Activities Subject to Antidegradation Review (ADR)

1. For all State waters, antidegradation reviews will be conducted for proposed federally regulated activities, such as those under Clean Water Act Sections 401 (FERC and other Federal actions), 402 (UPDES permits), and 404 (Army Corps of Engineers permits). The Executive Secretary may conduct an ADR on other projects with the potential for major impact on the quality of waters of the state. The review will determine whether the proposed activity complies with the applicable antidegradation requirements for the particular receiving waters that may be affected.

2. For High Quality Category 1 and High Quality Category 2 waters, reviews shall be consistent with the requirement established in Sections 3.2 and 3.3, respectively.

For State waters that do not have a High Quality Category 1 or High Quality Category 2 designation, reviews shall be consistent with the procedures identified in Section 3.4 a.-3.4 b.

The antidegradation review consists of two parts. An antidegradation Level I review will be to determine if the proposed activity requires an antidegradation Level II review as described in Section 3.4 b. below. If so, further review will be required.

b. An Anti-degradation Level II review is not required where any of the following conditions apply:

1. Water quality will not be lowered by the proposed activity (e.g., a UPDES permit is being renewed and the proposed effluent concentration value and pollutant loading is equal to or less than the existing effluent concentrations value and pollutant loading).

2. Discharge limits are established in an approved TMDL that is consistent with the current water quality standards for the receiving water (e.g., where TMDLs are established, changes in effluent limits that are consistent with the existing load allocation would not trigger an anti-degradation review), or

3. Water quality impacts will be temporary and related only to sediment or turbidity and fish spawning will not be impaired, or

4. The discharge is to a water quality limited water, and assimilative capacity is essentially allocated to existing discharges.

5. The water quality effects of the proposed activity are expected to be temporary and limited. As general guidance, CWA Section 402 general permits, CWA Section 404 nationwide and general permits, or activities of short duration, will be deemed to have a temporary and limited effect on water quality where there is a reasonable factual basis to support such a conclusion. The 404 nationwide permits decision will be made at the time of permit issuance, as part of the Division's water quality certification under DWA Section 401. Where it is determined that the category of activities will result in temporary and limited effects, subsequent individual activities authorized under such permits will not be subject to further antidegradation review. Factors to be considered in determining whether water quality effects will be temporary and limited may include the following:

(a) Length of time during which water quality will be lowered.

(b) Percent change in ambient concentrations of pollutants of concern

(c) Pollutants affected

(d) Likelihood for long-term water quality benefits to the segment (e.g., dredging of contaminated sediments)

(e) Potential for any residual long-term influences on existing uses.

6. The affected waters are classified as 3C, 3D (and not 3A or 3B), or 3E waters, or are classified only as Class 4.

7. The affected waters are considered to be poor quality fisheries as indicated by Utah Division of Wildlife Resource (UDWR) Classes IV, V, and VI with the exception of those waters which add a letter (P, R, N, B, X, or C) to the numerical rating and those which have a "unique rating".

8. The water body is listed on the current 303(d) list for the parameters of concern.

9. Existing water quality for the parameters of concern does not satisfy applicable numeric and narrative water quality criteria.

10. Water quality impacts are expected to be minor. For example: (a) for discharge permit renewals, if the increase in project loading over the prior permit is less than 20%; or (b) if

the increase in pollutant loading to the stream is less than 20% over existing background.

11. The volume of the discharge is small as compared to the flow of the receiving stream. In general, this would be considered where the ratio of the average stream flow to the discharged flow is expected to be greater than 100:1, the ratio of the 7Q10 (7 day-10 year) low flow to the discharge flow is expected to be greater than 25:1, and where the increase in concentration of the pollutants in the stream at 7Q10 at low flow is expected to be less than 10%, or based upon other site specific criteria.

Both Level I and Level II reviews will be conducted on a parameter-by-parameter basis. A decision to move to a Level II review for one parameter may not require a Level II review for other parameters that will be affected by the proposed activity. An antidegradation review may be required by the Executive Secretary if the receiving water is a drinking water source, if the receiving water has a special value for recreation or fisheries, if an existing use may be impaired, or based on other site-specific factors as appropriate.

c. Anti-degradation Review Process

For all activities requiring a Level II review, the Division will notify affected agencies and the public with regards to the requested proposed activity and discussions with stakeholders may be held. In the case of Section 402 discharge permits, if it is determined that a discharge will be allowed, the Division of Water Quality will develop any needed UPDES permits for public notice following the normal permit issuance process.

The ADR will cover the following requirements or determinations:

1. Will all Statutory and regulatory requirements be met?

The Executive Secretary will review to determine that there will be achieved all statutory and regulatory requirements for all new and existing point sources and all required cost-effective and reasonable best management practices for nonpoint source control in the area of the discharge. If point sources exist in the area that have not achieved all statutory and regulatory requirements, the Executive Secretary will consider whether schedules of compliance or other plans have been established when evaluating whether compliance has been assured. Generally, the "area of the discharge" will be determined based on the parameters of concern associated with the proposed activity and the portion of the receiving water that would be affected.

2. Are there any reasonable less-degrading alternatives?

There will be an evaluation of whether there are any reasonable non-degrading or less degrading alternatives for the proposed activity. This question will be addressed by the Division based on information provided by the project proponent. Control alternatives for a proposed activity will be evaluated in an effort to avoid or minimize degradation of the receiving water. Alternatives to be considered, evaluated, and implemented to the extent feasible, could include pollutant trading, water conservation, water recycling and reuse, land application, total containment, etc.

For proposed UPDES permitted discharges, the following list of alternatives should be considered, evaluated and implemented to the extent feasible:

(a) innovative or alternative treatment options
(b) more effective treatment options or higher treatment levels
(c) connection to other wastewater treatment facilities
(d) process changes or product or raw material substitution
(e) seasonal or controlled discharge options to minimize discharging during critical water quality periods
(f) seasonal or controlled discharge options to minimize discharging during critical water quality periods
(g) pollutant trading
(h) water conservation
(i) water recycle and reuse
(j) alternative discharge locations or alternative receiving waters
(k) land application
(l) total containment
(m) improved operation and maintenance of existing treatment systems
(n) other appropriate alternatives

An option more costly than the cheapest alternative may have to be implemented if a substantial benefit to the stream can be realized. Alternatives would generally be considered feasible where costs are no more than 20% higher than the cost of the discharging alternative, and (for POTWs) where the projected per connection service fees are not greater than 1.4% of MAGHI (median adjusted gross household income), the current affordability criterion now being used by the Water Quality Board in the wastewater revolving loan program. Alternatives within these cost ranges should be carefully considered by the discharger. Where State financing is appropriate, a financial assistance package may be influenced by this evaluation, i.e., a less polluting alternative may receive a more favorable funding arrangement in order to make it a more financially attractive alternative.

It must also be recognized in relationship to evaluating options that would avoid or reduce discharges to the stream, that in some situations it may be more beneficial to leave the water in the stream for instream flow purposes than to remove the discharge to the stream.

3. Special Procedures for 404 Permits.

For 404 permitted activities, all appropriate alternatives to avoid and minimize degradation should be evaluated. Activities involving a discharge of dredged or fill materials that are considered to have more than minor adverse affects on the aquatic environment are regulated by individual CWA Section 404 permits. The decision-making process relative to the 404 permitting program is contained in the 404(b)(1) guidelines (40 CFR Part 230). Prior to issuing a permit under the 404(b)(1) guidelines, the Corps of Engineers:

(a) makes a determination that the proposed activity discharges are unavoidable (i.e., necessary):
(b) examines alternatives to the proposed activity and

authorize only the least damaging practicable alternative; and

(c) requires mitigation for all impacts associated with the activity. A 404(b)(1) finding document is produced as a result of this procedure and is the basis for the permit decision. Public participation is provided for in the process. Because the 404(b)(1) guidelines contains an alternatives analysis, the executive secretary will not require development of a separate alternatives analysis for the anti-degradation review. The division will use the analysis in the 404(b)(1) finding document in completing its anti-degradation review and 401 certification.

4. Does the proposed activity have economic and social importance?

Although it is recognized that any activity resulting in a discharge to surface waters will have positive and negative aspects, information must be submitted by the applicant that any discharge or increased discharge will be of economic or social importance in the area.

The factors addressed in such a demonstration may include, but are not limited to, the following:

(a) employment (i.e., increasing, maintaining, or avoiding a reduction in employment);

(b) increased production;

(c) improved community tax base;

(d) housing;

(e) correction of an environmental or public health problem; and

(f) other information that may be necessary to determine the social and economic importance of the proposed surface water discharge.

5. The applicant may submit a proposal to mitigate any adverse environmental effects of the proposed activity (e.g., instream habitat improvement, bank stabilization). Such mitigation plans should describe the proposed mitigation measures and the costs of such mitigation. Mitigation plans will not have any effect on effluent limits or conditions included in a permit (except possibly where a previously completed mitigation project has resulted in an improvement in background water quality that affects a water quality-based limit). Such mitigation plans will be developed and implemented by the applicant as a means to further minimize the environmental effects of the proposed activity and to increase its socio-economic importance. An effective mitigation plan may, in some cases, allow the Executive Secretary to authorize proposed activities that would otherwise not be authorized.

6. Will water quality standards be violated by the discharge?

Proposed activities that will affect the quality of waters of the state will be allowed only where the proposed activity will not violate water quality standards.

7. Will existing uses be maintained and protected?

Proposed activities can only be allowed if "existing uses" will be maintained and protected. No UPDES permit will be allowed which will permit numeric water quality standards to be exceeded in a receiving water outside the mixing zone. In the case of

nonpoint pollution sources, the non-regulatory Section 319 program now in place will address these sources through application of best management practices to ensure that numeric water quality standards are not exceeded.

8. If a situation is found where there is an existing use which is a higher use (i.e., more stringent protection requirements) than that current designated use, the Division will apply the water quality standards and anti-degradation policy to protect the existing use. Narrative criteria may be used as a basis to protect existing uses for parameters where numeric criteria have not been adopted. Procedures to change the stream use designation to recognize the existing use as the designated use would be initiated.

d. Special Procedures for Drinking Water Sources

An Antidegradation Review may be required by the Executive Secretary for discharges to waters with a Class 1C drinking water use assigned, irrespective of whether any of the conditions in Section 3.4 b. applies. Factors to be considered may include the volume of the discharge compared to the flow of the receiving stream, or where the pollutants discharged may have potentially adverse impact on the drinking water supply.

Depending upon the locations of the discharge and its proximity to downstream drinking water diversions, additional treatment or more stringent effluent limits or additional monitoring, beyond that which may otherwise be required to meet minimum technology standards or in stream water quality standards, may be required by the Executive Secretary in order to adequately protect public health and the environment. Such additional treatment may include additional disinfection, suspended solids removal to make the disinfection process more effective, removal of any specific contaminants for which drinking water maximum contaminant levels (MCLs) exists, and/or nutrient removal to reduce the organic content of raw water used as a source for domestic water systems.

Additional monitoring may include analyses for viruses, giardia, cryptosporidium, other pathogenic organisms, and/or any contaminant for which drinking water MCLs exist. Depending on the results of such monitoring, more stringent treatment may then be required.

The additional treatment/effluent limits/monitoring which may be required will be determined by the Executive Secretary after consultation with the Division of Drinking Water and the downstream drinking water users.

e. Public Notice

The public will be provided notice and an opportunity to comment on the conclusions of all completed antidegradation reviews. Where possible, public notice on the antidegradation review conclusions will be combined with the public notice on the proposed permitting action. In the case of UPDES permits, public notice will be provided through the normal permitting process, as all draft permits are public noticed for 30 days, and public comment solicited, before being issued as a final permit. The Statement of Basis for the draft UPDES permit will contain information on how the ADR was addressed including results of the

Level I and Level II reviews. In the case of Section 404 permits from the Corps of Engineers, the Division of Water Quality will develop any needed 401 Certifications and the public notice will be published in conjunction with the US Corps of Engineers public notice procedures. Other permits requiring a Level II review will receive a separate public notice according to the normal State public notice procedures.

R317-2-4. Colorado River Salinity Standards.

In addition to quality protection afforded by these regulations to waters of the Colorado River and its tributaries, such waters shall be protected also by requirements of "Proposed Water Quality Standards for Salinity including Numeric Criteria and Plan of Implementation for Salinity Control, Colorado River System, June 1975" and a supplement dated August 26, 1975, entitled "Supplement, including Modifications to Proposed Water Quality Standards for Salinity including Numeric Criteria and Plan of Implementation for Salinity Control, Colorado River System, June 1975", as approved by the seven Colorado River Basin States and the U.S. Environmental Protection Agency, as updated by the 1978 Revision and the 1981, 1984, 1987, 1990, 1993, 1996, 1999 and 2002 Reviews of the above documents.

R317-2-5. Mixing Zones.

A mixing zone is a limited portion of a body of water, contiguous to a discharge, where dilution is in progress but has not yet resulted in concentrations which will meet certain standards for all pollutants. At no time, however, shall concentrations within the mixing zone be allowed which are acutely lethal as determined by bioassay or other approved procedure. Mixing zones may be delineated for the purpose of guiding sample collection procedures and to determine permitted effluent limits. The size of the chronic mixing zone in rivers and streams shall not to exceed 2500 feet and the size of an acute mixing zone shall not exceed 50% of stream width nor have a residency time of greater than 15 minutes. Streams with a flow equal to or less than twice the flow of a point source discharge may be considered to be totally mixed. The size of the chronic mixing zone in lakes and reservoirs shall not exceed 200 feet and the size of an acute mixing zone shall not exceed 35 feet. Domestic wastewater effluents discharged to mixing zones shall meet effluent requirements specified in R317-1-3.

5.1 Individual Mixing Zones. Individual mixing zones may be further limited or disallowed in consideration of the following factors in the area affected by the discharge:

a. Bioaccumulation in fish tissues or wildlife,

b. Biologically important areas such as fish spawning/nursery areas or segments with occurrences of federally listed threatened or endangered species,

c. Potential human exposure to pollutants resulting from drinking water or recreational activities,

d. Attraction of aquatic life to the effluent plume, where toxicity to the aquatic life is occurring.

e. Toxicity of the substance discharged,

f. Zone of passage for migrating fish or other species (including access to tributaries), or

g. Accumulative effects of multiple discharges and mixing zones.

R317-2-6. Use Designations.

The Board as required by Section 19-5-110, shall group the waters of the state into classes so as to protect against controllable pollution the beneficial uses designated within each class as set forth below. Surface waters of the state are hereby classified as shown in R317-2-13.

6.1 Class 1 -- Protected for use as a raw water source for domestic water systems.

a. Class 1A -- Reserved.

b. Class 1B -- Reserved.

c. Class 1C -- Protected for domestic purposes with prior treatment by treatment processes as required by the Utah Division of Drinking Water

6.2 Class 2 -- Protected for recreational use and aesthetics.

a. Class 2A -- Protected for primary contact recreation such as swimming.

b. Class 2B -- Protected for secondary contact recreation such as boating, wading, or similar uses.

6.3 Class 3 -- Protected for use by aquatic wildlife.

a. Class 3A -- Protected for cold water species of game fish and other cold water aquatic life, including the necessary aquatic organisms in their food chain.

b. Class 3B -- Protected for warm water species of game fish and other warm water aquatic life, including the necessary aquatic organisms in their food chain.

c. Class 3C -- Protected for nongame fish and other aquatic life, including the necessary aquatic organisms in their food chain.

d. Class 3D -- Protected for waterfowl, shore birds and other water-oriented wildlife not included in Classes 3A, 3B, or 3C, including the necessary aquatic organisms in their food chain.

e. Class 3E -- Severely habitat-limited waters. Narrative standards will be applied to protect these waters for aquatic wildlife.

6.4 Class 4 -- Protected for agricultural uses including irrigation of crops and stock watering.

6.5 Class 5 -- The Great Salt Lake. Protected for primary and secondary contact recreation, waterfowl, shore birds and other water-oriented wildlife including their necessary aquatic organisms in their food chain, and mineral extraction.

R317-2-7. Water Quality Standards.

7.1 Application of Standards

The numeric criteria listed in R317-2-14 shall apply to each of the classes assigned to waters of the State as specified in R317-2-6. It shall be unlawful and a violation of these regulations for any person to discharge or place any wastes or other substances in such manner as may interfere with designated uses protected by assigned classes or to cause any of the

applicable standards to be violated, except as provided in R317-1-3.1. The Board may allow site specific modifications based upon bioassay or other tests performed in accordance with standard procedures determined by the Board.

7.2 Narrative Standards

It shall be unlawful, and a violation of these regulations, for any person to discharge or place any waste or other substance in such a way as will be or may become offensive such as unnatural deposits, floating debris, oil, scum or other nuisances such as color, odor or taste; or cause conditions which produce undesirable aquatic life or which produce objectionable tastes in edible aquatic organisms; or result in concentrations or combinations of substances which produce undesirable physiological responses in desirable resident fish, or other desirable aquatic life, or undesirable human health effects, as determined by bioassay or other tests performed in accordance with standard procedures.

R317-2-8. Protection of Downstream Uses.

All actions to control waste discharges under these regulations shall be modified as necessary to protect downstream designated uses.

R317-2-9. Intermittent Waters.

Failure of a stream to meet water quality standards when stream flow is either unusually high or less than the 7-day, 10-year minimum flow shall not be cause for action against persons discharging wastes which meet both the requirements of R317-1 and the requirements of applicable permits.

R317-2-10. Laboratory and Field Analyses.

10.1 Laboratory Analyses

All laboratory examinations of samples collected to determine compliance with these regulations shall be performed in accordance with standard procedures as approved by the Utah Division of Water Quality by the Utah Office of State Health Laboratory or by a laboratory certified by the Utah Department of Health.

10.2 Field Analyses

All field analyses to determine compliance with these regulations shall be conducted in accordance with standard procedures specified by the Utah Division of Water Quality.

R317-2-11. Public Participation.

Public hearings will be held to review all proposed revisions of water quality standards, designations and classifications, and public meetings may be held for consideration of discharge requirements set to protect water uses under assigned classifications.

R317-2-12. High Quality Waters.

12.1 High Quality Waters - Category 1.

In addition to assigned use classes, the following surface waters of the State are hereby designated as High Quality Waters - Category 1:

a. All surface waters geographically located within the outer boundaries of U.S. National Forests whether on public or private lands with the following exceptions:

All High Quality Waters - Category 2 as listed in R317-2-12.2.

Weber River, a tributary to the Great Salt Lake, in the Weber River Drainage from Uintah to Mountain Green.

b. Other surface waters, which may include segments within U.S. National Forests as follows:

1. Colorado River Drainage

Calf Creek and tributaries, from confluence with Escalante River to headwaters.

Sand Creek and tributaries, from confluence with Escalante River to headwaters.

Mamie Creek and tributaries, from confluence with Escalante River to headwaters.

Deer Creek and tributaries, from confluence with Boulder Creek to headwaters (Garfield County).

Indian Creek and tributaries, through Newspaper Rock State Park to headwaters.

2. Green River Drainage

Price River (Lower Fish Creek from confluence with White River to Scofield Dam.

Range Creek and tributaries, from confluence with Green River to headwaters.

Strawberry River and tributaries, from confluence with Red Creek to headwaters.

Ashley Creek and tributaries, from Steinaker diversion to headwaters.

Jones Hole Creek and tributaries, from confluence with Green River to headwaters.

Green River, from state line to Flaming Gorge Dam.

Tollivers Creek, from confluence with Green River to headwaters.

Allen Creek, from confluence with Green River to headwaters.

3. Virgin River Drainage

North Fork Virgin River and tributaries, from confluence with East Fork Virgin River to headwaters.

East Fork Virgin River and tributaries from confluence with North Fork Virgin River to headwaters.

4. Kanab Creek Drainage

Kanab Creek and tributaries, from irrigation diversion at confluence with Reservoir Canyon to headwaters.

5. Bear River Drainage

Swan Creek and tributaries, from Bear Lake to headwaters.

North Eden Creek, from Upper North Eden Reservoir to headwaters.

Big Creek and tributaries, from Big Ditch diversion to headwaters.

Woodruff Creek and tributaries, from Woodruff diversion to headwaters.

6. Weber River Drainage

Burch Creek and tributaries, from Harrison Boulevard in Ogden to headwaters.

Hardscrabble Creek and tributaries, from confluence with East Canyon Creek to headwaters.

Chalk Creek and tributaries, from U.S. Highway 189 to headwaters.

Weber River and tributaries, from U.S. Highway 189 near Oakley to headwaters.

7. Jordan River Drainage

City Creek and tributaries, from City Creek Water Treatment Plant to headwaters (Salt Lake County).

Emigration Creek and tributaries, from Hogle Zoo to headwaters (Salt Lake County).

Red Butte Creek and tributaries, from Foothill Boulevard in Salt Lake City to headwaters.

Parley's Creek and tributaries, from 13th East in Salt Lake City to headwaters.

Mill Creek and tributaries, from Wasatch Boulevard in Salt Lake City to headwaters.

Big Cottonwood Creek and tributaries, from Wasatch Boulevard in Salt Lake City to headwaters.

Little Willow Creek and tributaries, from diversion to headwaters (Salt Lake County.)

Bell Canyon Creek and tributaries, from Lower Bells Canyon Reservoir to headwaters (Salt Lake County).

South Fork of Dry Creek and tributaries, from Draper Irrigation Company diversion to headwaters (Salt Lake County).

8. Provo River Drainage

Upper Falls drainage above Provo City diversion (Utah County).

Bridal Veil Falls drainage above Provo City diversion (Utah County).

Lost Creek and tributaries, above Provo City diversion (Utah County).

9. Sevier River Drainage

Chicken Creek and tributaries, from diversion at canyon mouth to headwaters.

Pigeon Creek and tributaries, from diversion to headwaters.

East Fork of Sevier River and tributaries, from Kingston diversion to headwaters.

Parowan Creek and tributaries, from Parowan City to headwaters.

Summit Creek and tributaries, from Summit City to headwaters.

Braffits Creek and tributaries, from canyon mouth to headwaters.

Right Hand Creek and tributaries, from confluence with Coal Creek to headwaters.

10. Raft River Drainage

Clear Creek and tributaries, from state line to headwaters (Box Elder County).

Birch Creek (Box Elder County), from state line to headwaters.

Cotton Thomas Creek from confluence with South Junction Creek to headwaters.

11. Western Great Salt Lake Drainage

All streams on the south slope of the Raft River Mountains

above 7000' mean sea level.

Donner Creek (Box Elder County), from irrigation diversion to Utah-Nevada state line.

Bettridge Creek (Box Elder County), from irrigation diversion to Utah-Nevada state line.

Clover Creek, from diversion to headwaters.

All surface waters on public land on the Deep Creek Mountains.

12. Farmington Bay Drainage

Holmes Creek and tributaries, from Highway US-89 to headwaters (Davis County).

Shepard Creek and tributaries, from Height Bench diversion to headwaters (Davis County).

Farmington Creek and tributaries, from Height Bench Canal diversion to headwaters (Davis County).

Steed Creek and tributaries, from Highway US-89 to headwaters (Davis County).

12.2 High Quality Waters - Category 2.

In addition to assigned use classes, the following surface waters of the State are hereby designated as High Quality Waters - Category 2:

a. Green River Drainage

Deer Creek, a tributary of Huntington Creek, from the forest boundary to 4800 feet upstream.

Electric Lake.

R317-2-13. Classification of Waters of the State (see R317-2-6).

13.1 Upper Colorado River Basin

a. Colorado River Drainage

TABLE

Paria River and tributaries, from state line to headwaters	2B		3C	4
All tributaries to Lake Powell, except as listed below	2B	3B		4
Escalante River and tributaries, from Lake Powell to confluence with Boulder Creek	2B		3C	4
Escalante River and tributaries, from confluence with Boulder Creek, including Boulder Creek, to headwaters	2B	3A		4
Dirty Devil River and tributaries, from Lake Powell to Fremont River	2B		3C	4
Deer Creek and tributaries, from confluence with Boulder Creek to headwaters	2B	3A		4

Fremont River and tributaries, from confluence with Muddy Creek to Capitol Reef National Park, except as listed below	1C	2B	3C	4
Pleasant Creek and tributaries, from confluence with Fremont Rive to East boundary of Capitol Reef National Park		2B	3C	4
Pleasant Creek and tributaries, from East boundary of Capitol Reef National Park to headwaters	1C	2B 3A		
Fremont River and tributaries, through Capitol Reef National Park to headwaters	1C	2B 3A		4
Muddy Creek and tributaries, from confluence with Fremont River to Highway U-10 crossing, except as listed below		2B	3C	4
Quitchupah Creek and Tributaries, from Highway U-10 crossing to headwaters		2B 3A		4
Ivie Creek and tributaries, from Highway U-10 to headwaters		2B 3A		4
Muddy Creek and tributaries, from Highway U-10 crossing to headwaters	1C	2B 3A		4
San Juan River and Tributaries, from Lake Powell to state line except As listed below:	1C	2B	3B	4
Johnson Creek and tributaries, from confluence with Recapture Creek to headwaters	1C	2B 3A		4
Verdure Creek and tributaries, from Highway US-191 crossing to headwaters		2B 3A		4
North Creek and tributaries, from confluence with Montezuma Creek to headwaters	1C	2B 3A		4

South Creek and tributaries, from confluence with Montezuma Creek to headwaters	1C	2B	3A		4
Spring Creek and tributaries, from confluence with Vega Creek to headwaters		2B	3A		4
Montezuma Creek and tributaries, from U.S. Highway 191 to headwaters	1C	2B	3A		4
Colorado River and tributaries, from Lake Powell to state line except as listed below	1C	2B		3B	4
Indian Creek and tributaries, through Newspaper Rock State Park to headwaters	1C	2B	3A		4
Kane Canyon Creek and tributaries, from confluence with Colorado River to headwaters		2B		3C	4
Mill Creek and tributaries, from confluence with Colorado River to headwaters	1C	2B	3A		4
Dolores River and tributaries, from confluence with Colorado River to state line		2B		3C	4
Roc Creek and tributaries, from confluence with Dolores River to headwaters		2B	3A		4
LaSal Creek and tributaries, from state line to headwaters		2B	3A		4
Lion Canyon Creek and tributaries, from state line to headwaters		2B	3A		4
Little Dolores River and tributaries, from confluence with Colorado River to state line		2B		3C	4
Bitter Creek and tributaries, from confluence with Colorado River to headwaters		2B		3C	4

b. Green River Drainage

TABLE

Green River and tributaries, from confluence with Colorado River to state line except as listed below:	1C	2B	3B		4
Thompson Creek and tributaries from Interstate Highway 70 to headwaters		2B		3C	4
San Rafael River and tributaries, from confluence with Green River to confluence with Ferron Creek		2B		3C	4
Ferron Creek and tributaries, from confluence with San Rafael River to Millsite Reservoir		2B		3C	4
Ferron Creek and tributaries, from Millsite Reservoir to headwaters	1C	2B	3A		4
Huntington Creek and tributaries, from confluence with Cottonwood Creek to Highway U-10 crossing		2B		3C	4
Huntington Creek and tributaries, from Highway U-10 crossing to headwaters	1C	2B	3A		4
Cottonwood Creek and tributaries, from confluence with Huntington Creek to Highway U-57 crossing		2B		3C	4
Cottonwood Creek and tributaries, from Highway U-57 crossing to headwaters	1C	2B	3A		4
Cottonwood Canal, Emery County	1C	2B		3E	4
Price River and tributaries, from confluence with Green River to Carbon Canal Diversion at Price City Golf Course		2B		3C	4
Except as listed below					
Grassy Trail Creek and tributaries, from Grassy Trail Creek Reservoir to headwaters	1C	2B	3A		4
Price River and tributaries, from Carbon Canal Diversion at Price City Golf Course to Price City Water Water Treatment Plant intake.		2B	3A		4
Price River and tributaries, from Price City Water Treatment Plant intake to headwaters	1C	2B	3A		4
Range Creek and tributaries, from confluence with Green					

River to Range Creek Ranch		2B	3A			4
Range Creek and tributaries, from Range Creek Ranch to headwaters	1C	2B	3A			4
Rock Creek and tributaries, from confluence with Green River to headwaters		2B	3A			4
Nine Mile Creek and tributaries, from confluence with Green River to headwaters		2B	3A			4
Pariette Draw and tributaries, from confluence with Green River to headwaters		2B		3B	3D	4
Willow Creek and tributaries (Uintah County), from confluence with Green River to headwaters		2B	3A			4
White River and tributaries, from confluence with Green River to state line, except as listed below		2B		3B		4
Bitter Creek and Tributaries from White River to Headwaters		2B	3A			4
Duchesne River and tributaries, from confluence with Green River to Myton Water Treatment Plant intake, except as listed below		2B		3B		4
Uinta River and tributaries, From confluence with Duchesne River to Highway US-40 crossing		2B		3B		4
Uinta River and tributaries, From Highway US-4- crossing to headwaters		2B	3A			4
Power House Canal from Confluence with Uinta River to headwaters		2B	3A			4
Whiterocks River and Canal, From Tridell Water Treatment Plant to Headwaters	1C	2B	3A			4
Duchesne River and tributaries, from Myton Water Treatment Plant intake to headwaters	1C	2B	3A			4
Lake Fork River and tributaries, from confluence with Duchesne River to headwaters	1C	2B	3A			4
Lake Fork Canal from Dry Gulch Canal Diversion to Moon Lake	1C	2B			3E	4
Dry Gulch Canal, from Myton Water Treatment						

Plant to Lake Fork Canal	1C	2B			3E	4
Ashley Creek and tributaries, from confluence with Green River to Steinaker diversion		2B		3B		4
Ashley Creek and tributaries, from Steinaker diversion to headwaters	1C	2B	3A			4
Big Brush Creek and tributaries, from confluence with Green River to Tyzack (Red Fleet) Dam		2B		3B		4
Big Brush Creek and tributaries, from Tyzack (Red Fleet) Dam to headwaters	1C	2B	3A			4
Jones Hole Creek and tributaries, from confluence with Green River to headwaters		2B	3A			
Diamond Gulch Creek and tributaries, from confluence with Green River to headwaters		2B	3A			4
Pot Creek and tributaries, from Crouse Reservoir to headwaters		2B	3A			4
Green River and tributaries, from Utah-Colorado state line to Flaming Gorge Dam except as listed below:		2B	3A			4
Sears Creek and tributaries, Daggett County		2B	3A			
Tolivers Creek and tributaries, Daggett County		2B	3A			
Red Creek and tributaries, from confluence with Green River to state line		2B		3C		4
Jackson Creek and tributaries, Daggett County		2B	3A			
Davenport Creek and tributaries, Daggett County		2B	3A			
Goslin Creek and tributaries, Daggett County		2B	3A			
Gorge Creek and tributaries, Daggett County		2B	3A			
Beaver Creek and tributaries, Daggett County		2B	3A			
O-Wi-Yu-Kuts Creek and tributaries, County		2B	3A			
Tributaries to Flaming Gorge Reservoir, except as listed below		2B	3A			4
Birch Spring Draw and tributaries, from Flaming Gorge Reservoir to headwaters		2B		3C		4

Spring Creek and tributaries, from Flaming Gorge Reservoir to headwaters		2B	3A	
All Tributaries of Flaming Gorge Reservoir from Utah-Wyoming state line to headwaters		2B	3A	4

13.2 Lower Colorado River Basin

a. Virgin River Drainage

TABLE

Beaver Dam Wash and tributaries, from Motoqua to headwaters		2B	3B	4
Virgin River and tributaries from state line to Quail Creek diversion		2B	3B	4
Santa Clara River from confluence with Virgin River to Gunlock Reservoir	1C	2B	3B	4
Santa Clara River and tributaries, from Gunlock Reservoir to headwaters		2B	3A	4
Leed's Creek, from confluence with Quail Creek to headwaters		2B	3A	4
Quail Creek from Quail Creek Reservoir to headwaters	1C	2B	3A	4
Ash Creek and tributaries, from confluence with Virgin River to Ash Creek Reservoir		2B	3A	4
Ash Creek and tributaries, From Ash Creek Reservoir to headwaters		2B	3A	4
Virgin River and tributaries, from the Quail Creek diversion to headwaters, except as listed below	1C	2B	3C	4
North Fork Virgin River and tributaries	1C	2B	3A	4
East Fork Virgin River, from town of Glendale to headwaters		2B	3A	4

Kolob Creek, from confluence with Virgin River to headwaters	2B	3A		4

b. Kanab Creek Drainage

TABLE

Kanab Creek and tributaries, from state line to irrigation diversion at confluence with Reservoir Canyon	2B		3C	4
Kanab Creek and tributaries, from irrigation diversion at confluence with Reservoir Canyon to headwaters	2B	3A		4
Johnson Wash and tributaries, from state line to confluence with Skutumpah Canyon	2B		3C	4
Johnson Wash and tributaries, from confluence with Skutumpah Canyon to headwaters	2B	3A		4

13.3 Bear River Basin

a. Bear River Drainage

TABLE

Bear River and tributaries, from Great Salt Lake to Utah-Idaho border, except as listed below:	2B	3B	3D	4
Perry Canyon Creek from U.S. Forest boundary to headwaters	2B	3A		4
Box Elder Creek from confluence with Black Slough to Brigham City Reservoir (the Mayor's Pond)	2B		3C	4
Box Elder Creek, from Brigham City Reservoir (the Mayor's Pond) to headwaters	2B	3A		4
Malad River and tributaries, from confluence with Bear River to state line	2B		3C	
Little Bear River and tributaries, from Cutler Reservoir to headwaters	2B	3A	3D	4

Logan River and tributaries, from Cutler Reservoir to headwaters		2B 3A	3D	4
Blacksmith Fork and tributaries, from confluence with Logan River to headwaters		2B 3A		4
Newton Creek and tributaries, from Cutler Reservoir to Newton Reservoir		2B 3A		4
Clarkston Creek and tributaries, from Newton Reservoir to headwaters		2B 3A		4
Birch Creek and tributaries, from confluence with Clarkston Creek to headwaters		2B 3A		4
Summit Creek and tributaries, from confluence with Bear River to headwaters		2B 3A		4
Cub River and tributaries, from confluence with Bear River to state line, except as listed below:		2B	3B	4
High Creek and tributaries, from confluence with Cub River to headwaters		2B 3A		4
All tributaries to Bear Lake from Bear Lake to headwaters, except as listed below		2B 3A		4
Swan Springs tributary to Swan Creek	1C	2B 3A		
Bear River and tributaries in Rich County		2B 3A		4
Bear River and tributaries, from Utah-Wyoming state line to headwaters (Summit County)		2B 3A		4
Mill Creek and tributaries, from state line to headwaters (Summit County)		2B 3A		4

13.4 Weber River Basin

a. Weber River Drainage

TABLE

Willard Creek, from Willard Bay Reservoir to headwaters		2B 3A		4
Weber River, from Great Salt Lake to Slaterville diversion, except as listed below:		2B	3C 3D	4
Four Mile Creek from I-15 To headwaters		2B 3A		4
Weber River and tributaries, from Slaterville diversion to Stoddard diversion, except as listed below		2B 3A		4
Ogden River and tributaries, From confluence with Weber River To Pineview Dam, except as listed Below		2B 3A		4
Wheeler Creek from Confluence with Ogden River to headwaters	1C	2B 3A		4
All tributaries to Pineview Reservoir	1C	2B 3A		4
Strongs Canyon Creek and Tributaries, from U.S. National Forest boundary to headwaters	1C	2B 3A		4
Burch Creek and tributaries, from Harrison Boulevard in Ogden to Headwaters	1C	2B 3A		
Spring Creek and tributaries, From U.S. National Forest Boundary to headwaters	1C	2B 3A		4
Weber River and tributaries, from Stoddard diversion to headwaters	1C	2B 3A		4

13.5 Utah Lake-Jordan River Basin
a. Jordan River Drainage

TABLE

Jordan River, from Farmington Bay to North Temple Street, Salt Lake City		2B	3B * 3D	4

Jordan River, from North Temple Street in Salt Lake City to confluence with Little Cottonwood Creek		2B	3B *		4
Surplus Canal from Great Salt Lake to the diversion from the Jordan River		2B	3B *	3D	4
Jordan River from confluence with Little Cottonwood Creek toNarrows Diversion		2B 3A			4
Jordan River, from Narrows Diversion to Utah Lake	1C	2B	3B		4
City Creek, from Memory Park in Salt Lake City to City Creek Water Treatment Plant		2B 3A			
City Creek, from City Creek Water Treatment Plant to headwaters	1C	2B 3A			
Red Butte Creek and tributaries, from Red Butte Reservoir to headwaters	1C	2B 3A			
Emigration Creek and tributaries, from Foothill Boulevard in Salt Lake City to headwaters		2B 3A			
Parley's Creek and tributaries, from 1300 East in Salt Lake City to Mountain Dell Reservoir to headwaters	1C	2B 3A			
Parley's Creek and tributaries, from Mountain Dell Reservoir to headwaters	1C	2B 3A			
Mill Creek (Salt Lake County) from confluence with Jordan River to Interstate Highway 15		2B	3C		4
Mill Creek (Salt Lake County) and tributaries from Interstate Highway 15 to headwaters		2B 3A			4
Big Cottonwood Creek and tributaries, from confluence with Jordan River to Big Cottonwood Water Treatment Plant		2B 3A			4
Big Cottonwood Creek and tributaries, from Big Cottonwood					

Water Treatment Plant to headwaters	1C	2B	3A	
Deaf Smith Canyon Creek and tributaries	1C	2B	3A	4
Little Cottonwood Creek and tributaries, from confluence with Jordan River to Metropolitan Water Treatment Plant		2B	3A	4
Little Cottonwood Creek and tributaries, from Metropolitan Water Treatment Plant to headwaters	1C	2B	3A	
Bell Canyon Creek and tributaries, from lower Bell's Canyon reservoir to headwaters	1C	2B	3A	
Little Willow Creek and tributaries, from Draper Irrigation Company diversion to headwaters	1C	2B	3A	
Big Willow Creek and tributaries, from Draper Irrigation Company diversion to headwaters	1C	2B	3A	
South Fork of Dry Creek and tributaries, from Draper Irrigation Company diversion to headwaters	1C	2B	3A	
All permanent streams on east slope of Oquirrh Mountains (Coon, Barney's, Bingham, Butterfield, and Rose Creeks)		2B	3D	4
Kersey Creek from confluence of C-7 Ditch to headwaters		2B	3D	

* Site specific criteria for dissolved oxygen. See Table 2.14.5.

b. Provo River Drainage

TABLE

Provo River and tributaries, from Utah Lake to Murdock diversion		2B	3A	4
Provo River and tributaries, from Murdock Diversion to headwaters, except as listed below	1C	2B	3A	4

Upper Falls drainage above Provo City diversion	1C	2B	3A	
Bridal Veil Falls drainage above Provo City diversion	1C	2B	3A	
Lost Creek and tributaries above Provo City diversion	1C	2B	3A	

c. Utah Lake Drainage

TABLE

Dry Creek and tributaries (above Alpine), from U.S. National Forest boundary to headwaters		2B	3A	4
American Fork Creek and tributaries, from diversion at mouth of American Fork Canyon to headwaters		2B	3A	4
Spring Creek and tributaries, from Utah Lake near Lehi to headwaters		2B	3A	4
Lindon Hollow Creek and tributaries, from Utah Lake to headwaters		2B	3B	4
Rock Canyon Creek and tributaries (East of Provo) from U.S. National Forest boundary to headwaters	1C	2B	3A	4
Mill Race (except from Interstate Highway 15 to the Provo City WWTP discharge) and tributaries from Utah Lake to headwaters		2B	3B	4
Mill Race from Interstate Highway 15 to the Provo City wastewater treatment plant discharge		2B	3B	4
Spring Creek and tributaries from Utah Lake (Provo Bay) to 50 feet upstream from the east boundary of the Industrial Parkway Road Right-of-way		2B	3B	4
Tributary to Spring Creek (Utah County) which receives the Springville City WWTP effluent from confluence with Spring Creek to headwaters		2B	3D	4

Spring Creek and tributaries from 50 feet upstream from the east boundary of the Industrial Parkway Road right-of-way to the headwaters	2B	3A			4
Ironton Canal from Utah Lake (Provo Bay) to the east boundary of the Denver and Rio Grande Western Railroad right-of-way	2B		3C		4
Ironton Canal from the east boundary of the Denver and Rio Grande Western Railroad right-of-way to the point of diversion from Spring Creek	2B	3A			4
Hobble Creek and tributaries, from Utah Lake to headwaters	2B	3A			4
Dry Creek and tributaries from Utah Lake (Provo Bay) to Highway-US 89	2B			3E	4
Dry Creek and tributaries from Highway-US 89 to headwaters	2B	3A			4
Spanish Fork River and tributaries, from Utah Lake to diversion at Moark Junction	2B		3B	3D	4
Spanish Fork River and tributaries, from diversion at Moark Junction to headwaters	2B	3A			4
Benjamin Slough and tributaries from Utah Lake to headwaters, except as listed below	2B		3B		4
Beer Creek (Utah County) from 4850 West (in NE1/4NE1/4 sec. 36, T.8 S., R.1 E.) to headwaters	2B		3C		4
Salt Creek, from Nephi diversion to headwaters	2B	3A			4
Currant Creek, from mouth of Goshen Canyon to Mona Reservoir	2B	3A			4
Burriston Creek, from Mona Reservoir to headwaters	2B	3A			4

Peteetneet Creek and tributaries, from irrigation diversion above Maple Dell to headwaters	2B	3A	4
Summit Creek and tributaries (above Santaquin), from U.S. National Forest boundary to headwaters	2B	3A	4
All other permanent streams entering Utah Lake	2B	3B	4

13.6 Sevier River Basin
a. Sevier River Drainage

TABLE

Sevier River and tributaries from Sevier Lake to Gunnison Bend Reservoir to U.S.National Forest boundary except as listed below	2B	3C	4
Beaver River and tributaries from Minersville City to headwaters	2B	3A	4
Little Creek and tributaries, From irrigation diversion to Headwaters	2B	3A	4
Pinto Creek and tributaries, From Newcastle Reservoir to Headwaters	2B	3A	4
Coal Creek and tributaries	2B	3A	4
Summit Creek and tributaries	2B	3A	4
Parowan Creek and tributaries	2B	3A	4
Tributaries to Sevier River from Sevier Lake to Gunnison Bend Reservoir from U.S. National Forest boundary to headwaters, including:	2B	3A	4
Pioneer Creek and tributaries, Millard County	2B	3A	4
Chalk Creek and tributaries, Millard County	2B	3A	4
Meadow Creek and tributaries, Millard County	2B	3A	4

Corn Creek and tributaries, Millard County	2B	3A			4
Sevier River and tributaries below U.S. National Forest boundary from Gunnison Bend Reservoir to Annabella Diversion except except as listed below	2B		3B		4
Oak Creek and tributaries, Millard County	2B	3A			4
Round Valley Creek and tributaries, Millard County	2B	3A			4
Judd Creek and tributaries, Juab County	2B	3A			4
Meadow Creek and tributaries, Juab County	2B	3A			4
Cherry Creek and tributaries Juab County	2B	3A			4
Tanner Creek and tributaries, Juab County	2B			3E	4
Baker Hot Springs, Juab County	2B		3D		4
Chicken Creek and tributaries, Juab County	2B	3A			4
San Pitch River and tributaries, from confluence with Sevier River to Highway U-132 crossing except As listed below:	2B		3C	3D	4
Twelve Mile Creek (South Creek) and tributaries, from U.S. Forest Service boundary to headwaters	2B	3A			4
Six Mile Creek and tributaries, Sanpete County	2B	3A			4
Manti Creek (South Creek) and tributaries, from U.S. Forest Service boundary to headwaters	2B	3A			4
Ephraim Creek (Cottonwood Creek) and tributaries, from U.S. Forest Service to					

headwaters		2B 3A	4
Oak Creek and tributaries, from U.S. Forest Service boundary near Spring City to headwaters		2B 3A	4
Fountain Green Creek and tributaries, from U.S. Forest Service boundary to headwaters		2B 3A	4
San Pitch River and tributaries, from Highway U-132 crossing to headwaters		2B 3A	4
Tributaries to Sevier River from Gunnison Bend Reservoir to Annabelle Diversion from U.S. National Forest boundary to headwaters		2B 3A	4
Sevier River and tributaries, from Annabella diversion to headwaters		2B 3A	4
Monroe Creek and tributaries, from diversion to headwaters		2B 3A	4
Little Creek and tributaries, from irrigation diversion to headwaters		2B 3A	4
Pinto Creek and tributaries, from Newcastle Reservoir to headwaters		2B 3A	4
Coal Creek and tributaries		2B 3A	4
Summit Creek and tributaries		2B 3A	4
Parowan Creek and tributaries		2B 3A	4
Duck Creek and tributaries	1C	2B 3A	4

13.7 Great Salt Lake Basin
a. Western Great Salt Lake Drainage

TABLE

Grouse Creek and tributaries, Box Elder County		2B 3A	4
Muddy Creek and tributaries, Box			

Elder County	2B	3A		4
Dove Creek and tributaries, Box Elder County	2B	3A		4
Pine Creek and tributaries, Box Elder County	2B	3A		4
Rock Creek and tributaries, Box Elder County	2B	3A		4
Fisher Creek and tributaries, Box Elder County	2B	3A		4
Dunn Creek and tributaries, Box Elder County	2B	3A		4
Indian Creek and tributaries, Box Elder County	2B	3A		4
Tenmile Creek and tributaries, Box Elder County	2B	3A		4
Curlew (Deep) Creek, Box Elder County	2B	3A		4
Blue Creek and tributaries, from Great Salt Lake to Blue Creek Reservoir	2B		3D	4
Blue Creek and tributaries, from Blue Creek Reservoir to headwaters	2B	3B		4
All perennial streams on the east slope of the Pilot Mountain Range	1C	2B	3A	4
Donner Creek and tributaries, from irrigation diversion to Utah-Nevada state line	2B	3A		4
Bettridge Creek and tributaries, from irrigation diversion to Utah-Nevada state line	2B	3A		4
North Willow Creek and tributaries, Tooele County	2B	3A		4
South Willow Creek and tributaries, Tooele County	2B	3A		4
Hickman Creek and tributaries, Tooele County	2B	3A		4

Barlow Creek and tributaries, Tooele County		2B 3A	4
Clover Creek and tributaries, Tooele County		2B 3A	4
Faust Creek and tributaries, Tooele County		2B 3A	4
Vernon Creek and tributaries, Tooele County		2B 3A	4
Ophir Creek and tributaries, Tooele County		2B 3A	4
Soldier Creek and Tributaries from the Drinking Water Treatment Facility Headwaters, Tooele County	1C	2B 3A	4
Settlement Canyon Creek and tributaries, Tooele County		2B 3A	4
Middle Canyon Creek and tributaries, Tooele County		2B 3A	4
Tank Wash and tributaries, Tooele County		2B 3A	4
Basin Creek and tributaries, Juab and Tooele Counties		2B 3A	4
Thomas Creek and tributaries, Juab County		2B 3A	4
Indian Farm Creek and tributaries, Juab County		2B 3A	4
Cottonwood Creek and tributaries, Juab County		2B 3A	4
Red Cedar Creek and tributaries, Juab County		2B 3A	4
Granite Creek and tributaries, Juab County		2B 3A	4
Trout Creek and tributaries, Juab County		2B 3A	4
Birch Creek and tributaries, Juab County		2B 3A	4
Deep Creek and tributaries,			

from Rock Spring Creek to headwaters, Juab and Tooele Counties		2B	3A		4
Cold Spring, Juab County		2B		3C 3D	
Cane Spring, Juab County		2B		3C 3D	
Lake Creek, from Garrison (Pruess) Reservoir to Nevada state line		2B	3A		4
Snake Creek and tributaries, Millard County		2B	3B		4
Salt Marsh Spring Complex, Millard County		2B	3A		
Twin Springs, Millard County		2B	3B		
Tule Spring, Millard County		2B		3C 3D	
Coyote Spring Complex, Millard County		2B		3C 3D	
Hamblin Valley Wash and tributaries, from Nevada state line to headwaters (Beaver and Iron Counties)		2B		3D	4
Indian Creek and tributaries, Beaver County, from Indian Creek Reservoir to headwaters		2B	3A		4
Shoal Creek and tributaries, Iron County		2B	3A		4

b. Farmington Bay Drainage

TABLE

Corbett Creek and tributaries, from Highway to headwaters		2B	3A		4
Kays Creek and tributaries, from Farmington Bay to U.S. National Forest boundary		2B	3B		4
North Fork Kays Creek and tributaries, from U.S. National Forest boundary to headwaters		2B	3A		4
Middle Fork Kays Creek and tributaries, from U.S. National Forest boundary to headwaters	1C	2B	3A		4
South Fork Kays Creek and tributaries, from U.S. National					

Forest boundary to headwaters	1C	2B	3A		4
Snow Creek and tributaries		2B		3C	4
Holmes Creek and tributaries, from Farmington Bay to U.S. National Forest boundary		2B	3B		4
Holmes Creek and tributaries, from U.S. National Forest boundary to headwaters	1C	2B	3A		4
Baer Creek and tributaries, from Farmington Bay to Interstate Highway 15		2B		3C	4
Baer Creek and tributaries, from Interstate Highway 15 to Highway US-89		2B	3B		4
Baer Creek and tributaries, from Highway US-89 to headwaters	1C	2B	3A		4
Shepard Creek and tributaries, from U.S. National Forest boundary to headwaters	1C	2B	3A		4
Farmington Creek and tributaries, from Farmington Bay Waterfowl Management Area to U.S. National Forest boundary		2B	3B		4
Farmington Creek and tributaries, from U.S. National Forest boundary to headwaters	1C	2B	3A		4
Rudd Creek and tributaries, from Davis aqueduct to headwaters		2B	3A		4
Steed Creek and tributaries, from U.S. National Forest boundary to headwaters	1C	2B	3A		4
Davis Creek and tributaries, from Highway US-89 to headwaters		2B	3A		4
Lone Pine Creek and tributaries, from Highway US-89 to headwaters		2B	3A		4
Ricks Creek and tributaries, from Highway I-15 to headwaters	1C	2B	3A		4
Barnard Creek and tributaries, from Highway US-89 to headwaters		2B	3A		4
Parrish Creek and tributaries, from Davis Aqueduct to headwaters		2B	3A		4
Deuel Creek and tributaries, (Centerville Canyon) from Davis Aqueduct to headwaters		2B	3A		4
Stone Creek and tributaries, from Farmington Bay Waterfowl Management Area to U.S. National Forest boundary		2B	3A		4
Stone Creek and tributaries, from U.S. National Forest boundary to headwaters	1C	2B	3A		4
Barton Creek and tributaries, from U.S. National Forest boundary to headwaters		2B	3A		4

Mill Creek (Davis County) and tributaries, from confluence with State Canal to U.S. National Forest boundary		2B	3B	4
Mill Creek (Davis County) and tributaries, from U.S. National Forest boundary to headwaters	1C	2B	3A	4
North Canyon Creek and tributaries, from U.S. National Forest boundary to headwaters		2B	3A	4
Howard Slough		2B	3C	4
Hooper Slough		2B	3C	4
Willard Slough		2B	3C	4
Willard Creek to Headwaters	1C	2B	3A	4
Chicken Creek to Headwaters	1C	2B	3A	4
Cold Water Creek to Headwaters	1C	2B	3A	4
One House Creek to Headwaters	1C	2B	3A	4
Garner Creek to Headwaters	1C	2B	3A	4

13.8 Snake River Basin

a. Raft River Drainage (Box Elder County)

TABLE

Raft River and tributaries		2B	3A	4
Clear Creek and tributaries, from Utah-Idaho state line to headwaters		2B	3A	4
Onemile Creek and tributaries, from Utah-Idaho state line to headwaters		2B	3A	4
George Creek and tributaries, from Utah-Idaho state line to headwaters		2B	3A	4
Johnson Creek and tributaries, from Utah-Idaho state line to headwaters		2B	3A	4
Birch Creek and tributaries, from state line to headwaters		2B	3A	4
Pole Creek and tributaries, from state line to headwaters		2B	3A	4
Goose Creek and tributaries		2B	3A	4
Hardesty Creek and tributaries, from state line to headwaters		2B	3A	4

Meadow Creek and tributaries, from state line to headwaters	2B	3A			4
13.9 All irrigation canals and ditches statewide, except as otherwise designated	2B			3E	4
13.10 All drainage canals and ditches statewide, except as otherwise designated	2B			3E	

13.11 National Wildlife Refuges and State Waterfowl Management Areas

TABLE

Bear River National Wildlife Refuge, Box Elder County	2B	3B	3D	
Brown's Park Waterfowl Management Area, Daggett County	2B	3A	3D	
Clear Lake Waterfowl Management Area, Millard County	2B	3C	3D	
Desert Lake Waterfowl Management Area, Emery County	2B	3C	3D	
Farmington Bay Waterfowl Management Area, Davis and Salt Lake Counties	2B	3C	3D	
Fish Springs National Wildlife Refuge, Juab County	2B	3C	3D	
Harold Crane Waterfowl Management Area, Box Elder County	2B	3C	3D	
Howard Slough Waterfowl Management Area, Weber County	2B	3C	3D	
Locomotive Springs Waterfowl Management Area, Box Elder County	2B	3B	3D	
Ogden Bay Waterfowl Management Area, Weber County	2B	3C	3D	
Ouray National Wildlife Refuge, Uintah County	2B	3B	3D	
Powell Slough Waterfowl Management Area, Utah County	2B	3C	3D	
Public Shooting Grounds Waterfowl				

Management Area, Box Elder County			2B		3C	3D
Salt Creek Waterfowl Management Area, Box Elder County			2B		3C	3D
Stewart Lake Waterfowl Management Area, Uintah County			2B	3B		3D
Timpie Springs Waterfowl Management Area, Tooele County			2B	3B		3D

13.12 Lakes and Reservoirs (20 Acres or Larger). All lakes not listed in 13.12 are assigned by default to the classification of the stream with which they are associated.

a. Beaver County

TABLE

Anderson Meadow Reservoir			2B	3A			4
Manderfield Reservoir			2B	3A			4
LaBaron Reservoir			2B	3A			4
Kent's Lake		2B	3A			4	
Minersville Reservoir			2B	3A		3D	4
Puffer Lake			2B	3A			
Three Creeks Reservoir			2B	3A			4

b. Box Elder County

TABLE

Cutler Reservoir (including portion in Cache County)			2B		3B	3D	4
Etna Reservoir			2B	3A			4
Lynn Reservoir			2B	3A			4
Mantua Reservoir			2B	3A			4
Willard Bay Reservoir		1C	2A	2B	3B	3D	4

c. Cache County

TABLE

Hyrum Reservoir			2A	2B	3A	**	4
Newton Reservoir				2B	3A		4

Porcupine Reservoir		2B	3A	4
Pelican Pond		2B	3B	4
Tony Grove Lake		2B	3A	4

d. Carbon County

TABLE

Grassy Trail Creek Reservoir	1C	2B	3A	4
Olsen Pond		2B	3B	4
Scofield Reservoir	1C	2B	3A	4

e. Daggett County

TABLE

Browne Reservoir		2B	3A	4
Daggett Lake		2B	3A	4
Flaming Gorge Reservoir (Utah portion)	1C 2A	2B	3A	4
Long Park Reservoir	1C	2B	3A	4
Sheep Creek Reservoir		2B	3A	4
Spirit Lake		2B	3A	4
Upper Potter Lake		2B	3A	4

f. Davis County

TABLE

Farmington Ponds		2B	3A	4
Kaysville Highway Ponds		2B	3A	4
Holmes Creek Reservoir		2B	3B	4

g. Duchesne County

TABLE

Allred Lake		2B	3A	4
Atwine Lake		2B	3A	4
Atwood Lake		2B	3A	4

Betsy Lake		2B 3A	4
Big Sandwash Reservoir	1C	2B 3A	4
Bluebell Lake		2B 3A	4
Brown Duck Reservoir		2B 3A	4
Butterfly Lake		2B 3A	4
Cedarview Reservoir		2B 3A	4
Chain Lake #1		2B 3A	4
Chepeta Lake		2B 3A	4
Clements Reservoir		2B 3A	4
Cleveland Lake		2B 3A	4
Cliff Lake		2B 3A	4
Continent Lake		2B 3A	4
Crater Lake		2B 3A	4
Crescent Lake		2B 3A	4
Daynes Lake		2B 3A	4
Dean Lake		2B 3A	4
Doll Lake		2B 3A	4
Drift Lake		2B 3A	4
Elbow Lake		2B 3A	4
Farmer's Lake		2B 3A	4
Fern Lake		2B 3A	4
Fish Hatchery Lake		2B 3A	4
Five Point Reservoir		2B 3A	4
Fox Lake Reservoir		2B 3A	4
Governor's Lake		2B 3A	4
Granddaddy Lake		2B 3A	4
Hoover Lake		2B 3A	4

Island Lake		2B	3A			4	
Jean Lake			2B	3A			4
Jordan Lake			2B	3A			4
Kidney Lake			2B	3A			4
Kidney Lake West			2B	3A			4
Lily Lake			2B	3A			4
Midview Reservoir (Lake Boreham)			2B		3B		4
Milk Reservoir			2B	3A			4
Mirror Lake			2B	3A			4
Mohawk Lake			2B	3A			4
Moon Lake	1C		2A	2B	3A		4
North Star Lake			2B	3A			4
Palisade Lake			2B	3A			4
Pine Island Lake			2B	3A			4
Pinto Lake			2B	3A			4
Pole Creek Lake			2B	3A			4
Potter's Lake			2B	3A			4
Powell Lake			2B	3A			4
Pyramid Lake		2A	2B	3A			4
Queant Lake			2B	3A			4
Rainbow Lake			2B	3A			4
Red Creek Reservoir			2B	3A			4
Rudolph Lake			2B	3A			4
Scout Lake		2A	2B	3A			4
Spider Lake			2B	3A			4
Spirit Lake			2B	3A			4
Starvation Reservoir	1C	2A	2B	3A			4

Superior Lake			2B	3A		4
Swasey Hole Reservoir			2B	3A		4
Taylor Lake			2B	3A		4
Thompson Lake			2B	3A		4
Timothy Reservoir #1			2B	3A		4
Timothy Reservoir #6			2B	3A		4
Timothy Reservoir #7			2B	3A		4
Twin Pots Reservoir		1C	2B	3A		4
Upper Stillwater Reservoir		1C	2B	3A		4
X - 24 Lake			2B	3A		4

h. Emery County

TABLE

Cleveland Reservoir			2B	3A		4
Electric Lake			2B	3A		4
Huntington Reservoir			2B	3A		4
Huntington North Reservoir		2A	2B		3B	4
Joe's Valley Reservoir		2A	2B	3A		4
Millsite Reservoir	1C	2A	2B	3A		4

i. Garfield County

TABLE

Barney Lake			2B	3A		4
Cyclone Lake			2B	3A		4
Deer Lake			2B	3A		4
Jacob's Valley Reservoir			2B		3C 3D	4
Lower Bowns Reservoir			2B	3A		4
North Creek Reservoir			2B	3A		4
Panguitch Lake			2B	3A		4

Pine Lake		2B	3A		4
Oak Creek Reservoir (Upper Bowns)		2B	3A		4
Pleasant Lake		2B	3A		4
Posey Lake		2B	3A		4
Purple Lake		2B	3A		4
Raft Lake		2B	3A		4
Row Lake #3		2B	3A		4
Row Lake #7		2B	3A		4
Spectacle Reservoir		2B	3A		4
Tropic Reservoir		2B	3A		4
West Deer Lake		2B	3A		4
Wide Hollow Reservoir		2B	3A		4

j. Iron County

TABLE

Newcastle Reservoir		2B	3A		4
Red Creek Reservoir		2B	3A		4
Yankee Meadow Reservoir		2B	3A		4

k. Juab County

TABLE

Chicken Creek Reservoir		2B		3C 3D	4
Mona Reservoir		2B	3B		4
Sevier Bridge (Yuba) Reservoir	2A	2B	3B		4

l. Kane County

TABLE

Navajo Lake		2B	3A		4

m. Millard County

TABLE

DMAD Reservoir			2B	3B		4
Fools Creek Reservoir			2B		3C 3D	4
Garrison Reservoir (Pruess Lake)			2B	3B		4
Gunnison Bend Reservoir			2B	3B		4

n. Morgan County

TABLE

East Canyon Reservoir	1C	2A	2B	3A		4
Lost Creek Reservoir	1C		2B	3A		4

o. Piute County

TABLE

Barney Reservoir			2B	3A		4
Lower Boxcreek Reservoir			2B	3A		4
Manning Meadow Reservoir					2B	3A 4
Otter Creek Reservoir			2B	3A		4
Piute Reservoir			2B	3A		4
Upper Boxcreek Reservoir			2B	3A		4

p. Rich County

TABLE

Bear Lake (Utah portion)		2A	2B	3A		4
Birch Creek Reservoir			2B	3A		4
Little Creek Reservoir			2B	3A		4
Woodruff Creek Reservoir			2B	3A		4

q. Salt Lake County

TABLE

Decker Lake			2B	3B	3D	4
Lake Mary	1C		2B	3A		

Little Dell Reservoir		1C		2B	3A	
Mountain Dell Reservoir		1C		2B	3A	

r. San Juan County

TABLE

Blanding Reservoir #4		1C		2B	3A	4
Dark Canyon Lake		1C		2B	3A	4
Ken's Lake				2B	3A**	4
Lake Powell (Utah portion)		1C	2A	2B	3B	4
Lloyd's Lake		1C		2B	3A	4
Monticello Lake				2B	3A	4
Recapture Reservoir				2B	3A	4

s. Sanpete County

TABLE

Duck Fork Reservoir				2B	3A	4
Fairview Lakes		1C		2B	3A	4
Ferron Reservoir				2B	3A	4
Lower Gooseberry Reservoir		1C		2B	3A	4
Gunnison Reservoir				2B	3C	4
Island Lake				2B	3A	4
Miller Flat Reservoir				2B	3A	4
Ninemile Reservoir				2B	3A	4
Palisade Reservoir			2A	2B	3A	4
Rolfson Reservoir				2B	3C	4
Twin Lakes				2B	3A	4
Willow Lake				2B	3A	4

t. Sevier County

TABLE

Annabella Reservoir	2B	3A	4
Big Lake	2B	3A	4
Farnsworth Lake	2B	3A	4
Fish Lake	2B	3A	4
Forsythe Reservoir	2B	3A	4
Johnson Valley Reservoir	2B	3A	4
Koosharem Reservoir	2B	3A	4
Lost Creek Reservoir	2B	3A	4
Redmond Lake	2B	3B	4
Rex Reservoir	2B	3A	4
Salina Reservoir	2B	3A	4
Sheep Valley Reservoir	2B	3A	4

u. Summit County

TABLE

Abes Lake	2B	3A	4
Alexander Lake	2B	3A	4
Amethyst Lake	2B	3A	4
Beaver Lake	2B	3A	4
Beaver Meadow Reservoir	2B	3A	4
Big Elk Reservoir	2B	3A	4
Blanchard Lake	2B	3A	4
Bridger Lake	2B	3A	4
China Lake	2B	3A	4
Cliff Lake	2B	3A	4
Clyde Lake	2B	3A	4
Coffin Lake	2B	3A	4
Cuberant Lake	2B	3A	4

East Red Castle Lake	2B 3A	4
Echo Reservoir	1C 2A 2B 3A	4
Fish Lake	2B 3A	4
Fish Reservoir	2B 3A	4
Haystack Reservoir #1	2B 3A	4
Henry's Fork Reservoir	2B 3A	4
Hoop Lake	2B 3A	4
Island Lake	2B 3A	4
Island Reservoir	2B 3A	4
Jesson Lake	2B 3A	4
Kamas Lake	2B 3A	4
Lily Lake	2B 3A	4
Lost Reservoir	2B 3A	4
Lower Red Castle Lake	2B 3A	4
Lyman Lake	2A 2B 3A	4
Marsh Lake	2B 3A	4
Marshall Lake	2B 3A	4
McPheters Lake	2B 3A	4
Meadow Reservoir	2B 3A	4
Meeks Cabin Reservoir	2B 3A	4
Notch Mountain Reservoir	2B 3A	4
Red Castle Lake	2B 3A	4
Rockport Reservoir	1C 2A 2B 3A	4
Ryder Lake	2B 3A	4
Sand Reservoir	2B 3A	4
Scow Lake	2B 3A	4
Smith Moorehouse Reservoir	1C 2B 3A	4

Star Lake		2B 3A	4
Stateline Reservoir		2B 3A	4
Tamarack Lake		2B 3A	4
Trial Lake	1C	2B 3A	4
Upper Lyman Lake		2B 3A	4
Upper Red Castle		2B 3A	4
Wall Lake Reservoir		2B 3A	4
Washington Reservoir		2B 3A	4
Whitney Reservoir		2B 3A	4

v. Tooele County

TABLE

Blue Lake		2B 3B	4
Clear Lake		2B 3B	4
Grantsville Reservoir		2B 3A	4
Horseshoe Lake		2B 3B	4
Kanaka Lake		2B 3B	4
Rush Lake		2B 3B	
Settlement Canyon Reservoir		2B 3A	4
Stansbury Lake		2B 3B	4
Vernon Reservoir		2B 3A	4

w. Uintah County

TABLE

Ashley Twin Lakes (Ashley Creek)	1C	2B 3A	4
Bottle Hollow Reservoir		2B 3A	4
Brough Reservoir		2B 3A	4
Calder Reservoir		2B 3A	4
Crouse Reservoir		2B 3A	4

East Park Reservoir			2B	3A		4
Fish Lake			2B	3A		4
Goose Lake #2			2B	3A		4
Matt Warner Reservoir			2B	3A		4
Oaks Park Reservoir			2B	3A		4
Paradise Park Reservoir			2B	3A		4
Pelican Lake			2B	3B		4
Red Fleet Reservoir	1C	2A	2B	3A		4
Steinaker Reservoir	1C	2A	2B	3A		4
Towave Reservoir			2B	3A		4
Weaver Reservoir			2B	3A		4
Whiterocks Lake			2B	3A		4
Workman Lake			2B	3A		4

x. Utah County

TABLE

Salem Pond		2A		3A		4
Silver Flat Lake Reservoir			2B	3A		4
Tibble Fork Resevoir			2B	3A		4
Utah Lake			2B	3B	3D	4

y. Wasatch County

TABLE

Currant Creek Reservoir	1C		2B	3A		4
Deer Creek Reservoir	1C	2A	2B	3A		4
Jordanelle Reservoir	1C	2A		3A		4
Mill Hollow Reservoir			2B	3A		4
Strawberry Reservoir	1C		2B	3A		4

z. Washington County

TABLE

Baker Dam Reservoir			2B	3A	4
Gunlock Reservoir	1C	2A	2B	3B	4
Ivins Reservoir			2B	3B	4
Kolob Reservoir			2B	3A	4
Lower Enterprise Reservoir			2B	3A	4
Quail Creek Reservoir	1C	2A	2B	3B	4
Upper Enterprise Reservoir			2B	3A	4

aa. Wayne County

TABLE

Blind Lake			2B	3A	4
Cook Lake			2B	3A	4
Donkey Reservoir			2B	3A	4
Fish Creek Reservoir			2B	3A	4
Mill Meadow Reservoir			2B	3A	4
Raft Lake			2B	3A	4

bb. Weber County

TABLE

Causey Reservoir			2B	3A	4
Pineview Reservoir	1C	2A	2B	3A**	4

13.13 Great Salt Lake

** For site specific temperature criteria See Table 2.14.2 Footnote 3.

TABLE

Box Elder, Davis, Salt Lake, Tooele, and Weber County	5

13.14 Unclassified Waters

All waters not specifically classified are presumptively classified as 2B, 3D.

R317-2-14. Numeric Criteria.

TABLE 2.14.1
NUMERIC CRITERIA FOR DOMESTIC,
RECREATION, AND AGRICULTURAL USES

Parameter	Domestic Source	Recreation and Aesthetics		Agri-culture
	1C	2A	2B	4
BACTERIOLOGICAL (30-DAY GEOMETRIC MEAN) (NO.)/100 ML) (7)				
E. coli	206	126	206	
MAXIMUM (NO.)/100 ML) (7)				
E. coli	940	576	940	
PHYSICAL				
pH (RANGE)	6.5-9.0	6.5-9.0	6.5-9.0	6.5-9.0
Turbidity Increase (NTU)		10	10	
METALS (DISSOLVED, MAXIMUM MG/L) (2)				
Arsenic	0.01			0.1
Barium	1.0			
Beryllium	<0.004			
Cadmium	0.01			0.01
Chromium	0.05			0.10
Copper				0.2
Lead	0.015			0.1
Mercury	0.002			
Selenium	0.05			0.05
Silver	0.05			
INORGANICS (MAXIMUM MG/L)				
Bromate	0.01			
Boron				0.75
Chlorite	<1.0			
Fluoride (3)	1.4-2.4			
Nitrates as N	10			
Total Dissolved Solids (4)	Irrigation			1200
	Stock Watering			2000
RADIOLOGICAL (MAXIMUM pCi/L)				
Gross Alpha	15			15
Gross Beta	4 mrem/yr			
Radium 226, 228				

(Combined)	5
Strontium 90	8
Tritium	20000
Uranium	30

ORGANICS
(MAXIMUM UG/L)

Chlorophenoxy Herbicides	
2,4-D	70
2,4,5-TP	10
Methoxychlor	40

POLLUTION
INDICATORS (5)

BOD (MG/L)			5	5	5
Nitrate as N (MG/L)	4	4			
Total Phosphorus as P (MG/L) (6)		0.05	0.05		

FOOTNOTES:

(1) Reserved

(2) The dissolved metals method involves filtration of the sample in the field, acidification of the sample in the field, no digestion process in the laboratory, and analysis by atomic absorption or inductively coupled plasma (ICP) spectrophotometry.

(3) Maximum concentration varies according to the daily maximum mean air temperature.

TEMP (C)	MG/L
12.0	2.4
12.1-14.6	2.2
14.7-17.6	2.0
17.7-21.4	1.8
21.5-26.2	1.6
26.3-32.5	1.4

(4) Total dissolved solids (TDS) limits may be adjusted if such adjustment does not impair the designated beneficial use of the receiving water. The total dissolved solids (TDS) standards shall be at background where it can be shown that natural or un-alterable conditions prevent its attainment. In such cases rulemaking will be undertaken to modify the standard accordingly.

Site Specific Standards for Total Dissolved Solids (TDS)

Castle Creek from confluence with the Colorado River to Seventh Day
Adventist Diversion: 1,800 mg/l;

Cottonwood Creek from the confluence with Huntington Creek to I-

57:
3,500 mg/l;

Ferron Creek from the confluence with San Rafael River to Highway 10: 3,500 mg/l;

Gordon Creek from the confluence with Price River to headwaters: 3,800 mg/l;

Huntington Creek and tributaries from the confluence with Cottonwood
Creek to U-10: 4,800 mg/l;

Ivie Creek and its tributaries from the confluence with Muddy Creek
to U-10: 2,600 mg/l;

Lost Creek from the confluence with Sevier River to U.S. Forest Service Boundary: 4,600 mg/l;

Muddy Creek and tributaries from the confluence with Quitchupah Creek to U-10: 2,600 mg/l;

Muddy Creek from confluence with Fremont River to confluence with Quitchupah Creek: 5,800 mg/l;

North Creek from the confluence with Virgin River to headwaters: 2,035 mg/l;

Onion Creek from the confluence with Colorado River to road crossing
above Stinking Springs: 3000 mg/l;

Brine Creek-Petersen Creek, from the confluence with the Sevier River to U-119 Crossing: 9,700 mg/l;

Pinnacle Creek from the confluence with Price River to headwaters: 3,800 mg/l;

Price River and tributaries from the confluence with Coal Creek to Carbon Canal Diversion: 1,700 mg/l;

Price River and tributaries from the confluence with Green River to
confluence with Soldier Creek: 3,000 mg/l;

Quitchupah Creek from the confluence with Ivie Creek to U-10: 2,600 mg/l;
Rock Canyon Creek from the confluence with Cottonwood Creek to headwaters: 3,500 mg/l;

San Pitch River from below Gunnison Reservoir to the Sevier River: 2,400 mg/l;

San Rafael River from the confluence with the Green River to Buckhorn Crossing: 4,100 mg/l;

San Rafael River from the Buckhorn Crossing to the confluence with Huntington Creek and Cottonwood Creek: 3,500 mg/l;

Sevier River between Gunnison Bend Reservoir and DMAD Reservoir: 1,725 mg/l;

Sevier River from Gunnison Bend Reservoir to Clear Lake: 3,370 mg/l;

Virgin River from the Utah/Arizona border to Pah Tempe Springs: 2,360 mg/l

(5) Investigations should be conducted to develop more information where these pollution indicator levels are exceeded.

(6) Total Phosphorus as P (mg/l) indicator for lakes and reservoirs shall be 0.025.

(7) Where the criteria are exceeded and there is a reasonable basis for concluding that the indicator bacteria are primarily from natural sources (wildlife), e.g., in National Wildlife Refuges and State Waterfowl Management Areas, the criteria may be considered attained. Exceedences of bacteriological numeric criteria from nonhuman nonpoint sources will generally be addressed through appropriate Federal, State, and local nonpoint source programs.

TABLE 2.14.2
NUMERIC CRITERIA FOR AQUATIC WILDLIFE

Parameter	Aquatic Wildlife			
	3A	3B	3C	3D
PHYSICAL				
Total Dissolved Gases	(1)	(1)		
Minimum Dissolved Oxygen (MG/L) (2)				
30 Day Average	6.5	5.5	5.0	5.0
7 Day Average	9.5/5.0	6.0/4.0		
1 Day Average	8.0/4.0	5.0/3.0	3.0	3.0
Max. Temperature(C)(3)	20	27	27	
Max. Temperature Change (C)(3)	2	4	4	
pH (Range)	6.5-9.0	6.5-9.0	6.5-9.0	6.5-9.0
Turbidity Increase (NTU)	10	10	15	15
METALS (4) (DISSOLVED, UG/L)(5)				
Aluminum				
4 Day Average (6)	87	87	87	87
1 Hour Average	750	750	750	750

Arsenic (Trivalent)				
4 Day Average	150	150	150	150
1 Hour Average	340	340	340	340
Cadmium (7)				
4 Day Average	0.25	0.25	0.25	0.25
1 Hour Average	2.0	2.0	2.0	2.0
Chromium (Hexavalent)				
4 Day Average	11	11	11	11
1 Hour Average	16	16	16	16
Chromium (Trivalent) (7)				
4 Day Average	74	74	74	74
1 Hour Average	570	570	570	570
Copper (7)				
4 Day Average	9	9	9	9
1 Hour Average	13	13	13	13
Cyanide (Free)				
4 Day Average	5.2	5.2	5.2	
1 Hour Average	22	22	22	22
Iron (Maximum)	1000	1000	1000	1000
Lead (7)				
4 Day Average	2.5	2.5	2.5	2.5
1 Hour Average	65	65	65	65
Mercury				
4 Day Average	0.012	0.012	0.012	0.012
1 Hour Average	2.4	2.4	2.4	2.4
Nickel (7)				
4 Day Average	52	52	52	52
1 Hour Average	468	468	468	468
Selenium				
4 Day Average	4.6	4.6	4.6	4.6
1 Hour Average	18.4	18.4	18.4	18.4
Silver				
1 Hour Average (7)	1.6	1.6	1.6	1.6
Zinc (7)				
4 Day Average	120	120	120	120
1 Hour Average	120	120	120	120
INORGANICS (MG/L) (4)				
Total Ammonia as N (9)				
30 Day Average	(9a)	(9a)		
1 Hour Average	(9b)	(9b)	(9b)	(9b)
Chlorine (Total Residual)				
4 Day Average	0.011	0.011	0.011	0.011
1 Hour Average	0.019	0.019	0.019	0.019
Hydrogen Sulfide (13)				
(Undissociated, Max. UG/L)	2.0	2.0	2.0	2.0
Phenol (Maximum)	0.01	0.01	0.01	0.01
RADIOLOGICAL (MAXIMUM pCi/L)				
Gross Alpha (10)	15	15	15	15

ORGANICS (UG/L) (4)				
Aldrin				
1 Hour Average	1.5	1.5	1.5	1.5
Chlordane				
4 Day Average	0.0043	0.0043	0.0043	0.0043
1 Hour Average	1.2	1.2	1.2	1.2
4,4' -DDT				
4 Day Average	0.0010	0.0010	0.0010	0.0010
1 Hour Average	0.55	0.55	0.55	0.55
Dieldrin				
4 Day Average	0.056	0.056	0.056	0.056
1 Hour Average	0.24	0.24	0.24	0.24
Alpha-Endosulfan				
4 Day Average	0.056	0.056	0.056	0.056
1 Hour Average	0.11	0.11	0.11	0.11
beta-Endosulfan				
4 Day Average	0.056	0.056	0.056	0.056
1 Day Average	0.11	0.11	0.11	0.11
Endrin				
4 Day Average	0.036	0.036	0.036	0.036
1 Hour Average	0.086	0.086	0.086	0.086
Heptachlor				
4 Day Average	0.0038	0.0038	0.0038	0.0038
1 Hour Average	0.26	0.26	0.26	0.26
Heptachlor epoxide				
4 Day Average	0.0038	0.0038	0.0038	0.0038
1 Hour Average	0.26	0.26	0.26	0.26
Hexachlorocyclohexane (Lindane)				
4 Day Average	0.08	0.08	0.08	0.08
1 Hour Average	1.0	1.0	1.0	1.0
Methoxychlor (Maximum)	0.03	0.03	0.03	0.03
Mirex (Maximum)	0.001	0.001	0.001	0.001
Parathion				
4 Day Average	0.013	0.013	0.013	0.013
1 Hour Average	0.066	0.066	0.066	0.066
PCB's				
4 Day Average	0.014	0.014	0.014	0.014
Pentachlorophenol (11)				
4 Day Average	15	15	15	15
1 Hour Average	19	19	19	19
Toxaphene				
4 Day Average	0.0002	0.0002	0.0002	0.0002
1 Hour Average	0.73	0.73	0.73	0.73
POLLUTION INDICATORS (11)				
Gross Beta (pCi/L)	50	50	50	50
BOD (MG/L)	5	5	5	5
Nitrate as N (MG/L)	4	4	4	
Total Phosphorus as P (MG/L) (12)	0.05	0.05		

FOOTNOTES:

(1) Not to exceed 110% of saturation.

(2) These limits are not applicable to lower water levels in deep impoundments. First number in column is for when early life stages are present, second number is for when all other life stages present.

(3) The temperature standard shall be at background where it can be shown that natural or un-alterable conditions prevent its attainment. In such cases rulemaking will be undertaken to modify the standard accordingly.

Site Specific Standards for Temperature

Ken's Lake: From June 1st - September 20th, 27 degrees C.

(4) Where criteria are listed as 4-day average and 1-hour average concentrations, these concentrations should not be exceeded more often than once every three years on the average.

(5) The dissolved metals method involves filtration of the sample in the field, acidification of the sample in the field, no digestion process in the laboratory, and analysis by atomic absorption spectrophotometry or inductively coupled plasma (ICP).

(6) The criterion for aluminum will be implemented as follows:

Where the pH is equal to or greater than 7.0 and the hardness is equal to or greater than 50 ppm as CaC03 in the receiving water after mixing, the 87 ug/1 chronic criterion (expressed as total recoverable) will not apply, and aluminum will be regulated based on compliance with the 750 ug/1 acute aluminum criterion (expressed as total recoverable).

(7) Hardness dependent criteria. 100 mg/l used. Conversion factors for ratio of total recoverable metals to dissolved metals must also be applied. In waters with a hardness greater than 400 mg/l as CaC03, calculations will assume a hardness of 400 mg/l as CaC03. See Table 2.14.3 for complete equations for hardness and conversion factors.

(8) Reserved

(9) The following equations are used to calculate Ammonia criteria concentrations:

(9a) The thirty-day average concentration of total ammonia nitrogen (in mg/l as N) does not exceed, more than once every three years on the average, the chronic criterion calculated using the following equations.

Fish Early Life Stages are Present:

$$\text{mg/l as N (Chronic)} = ((0.0577/1+10^{7.688-pH}) + (2.487/1+10^{pH-7.688})) * MIN(2.85, 1.45*10^{0.028*(25-T)})$$

Fish Early Life Stages are Absent:

$$\text{mg/l as N (Chronic)} = ((0.0577/1+10^{7.688-pH}) + (2.487/1+10^{pH-7.688})) * 1.45*10^{0.028*(25-MAX(T,7))})$$

(9b) The one-hour average concentration of total ammonia nitrogen (in mg/l as N) does not exceed, more than once every three years on the average the acute criterion calculated using the following equations.

Class 3A:

$$\text{mg/l as N (Acute)} = (0.275/(1+10^{7.204-pH})) + (39.0/1+10^{pH-7.204}))$$

Class 3B, 3C, 3D:

mg/l as N (Acute) = $0.411/(1+10^{7.204-pH})) + (58.4/(1+10^{pH-7.204}))$
In addition, the highest four-day average within the 30-day period should not exceed 2.5 times the chronic criterion. The "Fish Early Life Stages are Present" 30-day average total ammonia criterion will be applied by default unless it is determined by the Division, on a site-specific basis, that it is appropriate to apply the "Fish Early Life Stages are Absent" 30-day average criterion for all or some portion of the year. At a minimum, the "Fish Early Life Stages are Present" criterion will apply from the beginning of spawning through the end of the early life stages. Early life stages include the pre-hatch embryonic stage, the post-hatch free embryo or yolk-sac fry stage, and the larval stage for the species of fish expected to occur at the site. The division will consult with the Division of Wildlife Resources in making such determinations. The Division will maintain information regarding the waterbodies and time periods where application of the "Early Life Stages are Absent" criterion is determined to be appropriate.

(10) Investigation should be conducted to develop more information where these levels are exceeded.

(11) pH dependent criteria. pH 7.8 used in table. See Table 2.14.4 for equation.

(12) Total Phosphorus as P (mg/l) indicator for lakes and reservoirs shall be 0.025.

(13) Formula to convert dissolved sulfide to un-disassociated hydrogen sulfide is: H_2S = Dissolved Sulfide * $e^{((-1.92 + pH) + 12.05)}$

TABLE
1-HOUR AVERAGE (ACUTE) CONCENTRATION OF
TOTAL AMMONIA AS N (MG/L)

pH	Class 3A	Class 3B, 3C, 3D
6.5	32.6	48.8
6.6	31.3	46.8
6.7	29.8	44.6
6.8	28.1	42.0
6.9	26.2	39.1
7.0	24.1	36.1
7.1	22.0	32.8
7.2	19.7	29.5
7.3	17.5	26.2
7.4	15.4	23.0
7.5	13.3	19.9
7.6	11.4	17.0
7.7	9.65	14.4
7.8	8.11	12.1
7.9	6.77	10.1
8.0	5.62	8.40
8.1	4.64	6.95
8.2	3.83	5.72
8.3	3.15	4.71
8.4	2.59	3.88

8.5	2.14	3.20
8.6	1.77	2.65
8.7	1.47	2.20
8.8	1.23	1.84
8.9	1.04	1.56
9.0	0.89	1.32

TABLE
30-DAY AVERAGE (CHRONIC) CONCENTRATION OF
TOTAL AMMONIA AS N (MG/l)

Fish Early Life Stages Present
Temperature, C

pH	0	14	16	18	20	22	24	26	28	30
6.5	6.67	6.67	6.06	5.33	4.68	4.12	3.62	3.18	2.80	2.46
6.6	6.57	6.57	5.97	5.25	4.61	4.05	3.56	3.13	2.75	2.42
6.7	6.44	6.44	5.86	5.15	4.52	3.98	3.50	3.07	2.70	2.37
6.8	6.29	6.29	5.72	5.03	4.42	3.89	3.42	3.00	2.64	2.32
6.9	6.12	6.12	5.56	4.89	4.30	3.78	3.32	2.92	2.57	2.25
7.0	5.91	5.91	5.37	4.72	4.15	3.65	3.21	2.82	2.48	2.18
7.1	5.67	5.67	5.15	4.53	3.98	3.50	3.08	2.70	2.38	2.09
7.2	5.39	5.39	4.90	4.31	3.78	3.33	2.92	2.57	2.26	1.99
7.3	5.08	5.08	4.61	4.06	3.57	3.13	2.76	2.42	2.13	1.87
7.4	4.73	4.73	4.30	3.78	3.32	2.92	2.57	2.26	1.98	1.74
7.5	4.36	4.36	3.97	3.49	3.06	2.69	2.37	2.08	1.83	1.61
7.6	3.98	3.98	3.61	3.18	2.79	2.45	2.16	1.90	1.67	1.47
7.7	3.58	3.58	3.25	2.86	2.51	2.21	1.94	1.71	1.50	1.32
7.8	3.18	3.18	2.89	2.54	2.23	1.96	1.73	1.52	1.33	1.17
7.9	2.80	2.80	2.54	2.24	1.96	1.73	1.52	1.33	1.17	1.03
8.0	2.43	2.43	2.21	1.94	1.71	1.50	1.32	1.16	1.02	0.90
8.1	2.10	2.10	1.91	1.68	1.47	1.29	1.14	1.00	0.88	0.77
8.2	1.79	1.79	1.63	1.43	1.26	1.11	0.97	0.86	0.75	0.66
8.3	1.52	1.52	1.39	1.22	1.07	0.94	0.83	0.73	0.64	0.56
8.4	1.29	1.29	1.17	1.03	0.91	0.80	0.70	0.62	0.54	0.48
8.5	1.09	1.09	0.99	0.87	0.76	0.67	0.59	0.52	0.46	0.40
8.6	0.92	0.92	0.84	0.73	0.65	0.57	0.50	0.44	0.39	0.34
8.7	0.78	0.78	0.71	0.62	0.55	0.48	0.42	0.37	0.33	0.29
8.8	0.66	0.66	0.60	0.53	0.46	0.41	0.36	0.32	0.28	0.24
8.9	0.56	0.56	0.51	0.45	0.40	0.35	0.31	0.27	0.24	0.21
9.0	0.49	0.49	0.44	0.39	0.34	0.30	0.26	0.23	0.20	0.18

TABLE
30-DAY AVERAGE (CHRONIC) CONCENTRATION OF
TOTAL AMMONIA AS N (MG/l)

Fish Early Life Stages Absent
Temperature, C

pH	0-7	8	9	10	11	12	13	14	16
6.5	10.8	10.1	9.51	8.92	8.36	7.84	7.36	6.89	6.06
6.6	10.7	10.1	9.37	9.37	8.79	8.24	7.72	7.24	6.36
6.7	10.5	9.99	9.20	8.62	8.08	7.58	7.11	6.66	5.86

6.8	10.2	9.81	8.98	8.42	7.90	7.40	6.94	6.51	5.72
6.9	9.93	9.31	8.73	8.19	7.68	7.20	6.75	6.33	5.56
7.0	9.60	9.00	8.43	7.91	7.41	6.95	6.52	6.11	5.37
7.1	9.20	8.63	8.09	7.58	7.11	6.67	6.25	5.86	5.15
7.2	8.75	8.20	7.69	7.21	6.76	6.34	5.94	5.57	4.90
7.3	8.24	7.73	7.25	6.79	6.37	5.97	5.60	5.25	4.61
7.4	7.69	7.21	6.76	6.33	5.94	5.57	5.22	4.89	4.30
7.5	7.09	6.64	6.23	5.84	5.48	5.13	4.81	4.51	3.97
7.6	6.46	6.05	5.67	5.32	4.99	4.68	4.38	4.11	3.61
7.7	5.81	5.45	5.11	4.79	4.49	4.21	3.95	3.70	3.25
7.8	5.17	4.84	4.54	4.26	3.99	3.74	3.51	3.29	2.89
7.9	4.54	4.26	3.99	3.74	3.51	3.29	3.09	2.89	2.54
8.0	3.95	3.70	3.47	3.26	3.05	2.86	2.68	2.52	2.21
8.1	3.41	3.19	2.99	2.81	2.63	2.47	2.31	2.17	1.91
8.2	2.91	2.73	2.56	2.40	2.25	2.11	1.98	1.85	1.63
8.3	2.47	2.32	2.18	2.04	1.91	1.79	1.68	1.58	1.39
8.4	2.09	1.96	1.84	1.73	1.62	1.52	1.42	1.33	1.17
8.5	1.77	1.66	1.55	1.46	1.37	1.28	1.20	1.13	0.990
8.6	1.49	1.40	1.31	1.23	1.15	1.08	1.01	0.951	0.836
8.7	1.26	1.18	1.11	1.04	0.976	0.915	0.858	0.805	0.707
8.8	1.07	1.01	0.944	0.885	0.829	0.778	0.729	0.684	0.601
8.9	0.917	0.860	0.806	0.758	0.709	0.664	0.623	0.584	0.513
9.0	0.790	0.740	.694	0.651	0.610	0.572	0.536	0.503	0.442

pH	18	20	22	24	26	28	30
6.5	5.33	4.68	4.12	3.62	3.18	2.80	2.46
6.6	5.25	4.61	4.05	3.56	3.13	2.75	2.42
6.7	5.15	4.52	3.98	3.50	3.07	2.70	2.37
6.8	5.03	4.42	3.89	3.42	3.00	2.64	2.32
6.9	4.89	4.30	3.78	3.32	2.92	2.57	2.25
7.0	4.72	4.15	3.65	3.21	2.82	2.48	2.18
7.1	4.53	3.98	3.50	3.08	2.70	2.38	2.09
7.2	4.41	3.78	3.33	2.92	2.57	2.26	1.99
7.3	4.06	3.57	3.13	2.76	2.42	2.13	1.87
7.4	3.78	3.32	2.92	2.57	2.26	1.98	1.74
7.5	3.49	3.06	2.69	2.37	2.08	1.83	1.61
7.6	3.18	2.79	2.45	2.16	1.90	1.67	1.47
7.7	2.86	2.51	2.21	1.94	1.71	1.50	1.32
7.8	2.54	2.23	1.96	1.73	1.52	1.33	1.17
7.9	2.24	1.96	1.73	1.52	1.33	1.17	1.03
8.0	0.94	1.71	1.50	1.32	1.16	1.02	0.897
8.1	0.68	1.47	1.29	1.14	1.00	0.879	0.733
8.2	0.43	1.26	1.11	0.073	0.855	0.752	0.661
8.3	0.22	1.07	0.941	0.827	0.727	0.639	0.562
8.4	0.03	0.906	0.796	0.700	0.615	0.541	0.475
8.5	0.870	0.765	0.672	0.591	0.520	0.457	0.401
8.6	0.735	0.646	0.568	0.499	0.439	0.396	0.339
8.7	0.622	0.547	0.480	0.422	0.371	0.326	0.287
8.8	0.528	0.464	0.408	0.359	0.315	0.277	0.244
8.9	0.451	0.397	0.349	0.306	0.269	0.237	0.208
9.0	0.389	0.342	0.300	0.264	0.232	0.204	0.179

TABLE 2.14.3a

EQUATIONS TO CONVERT TOTAL RECOVERABLE METALS STANDARD WITH HARDNESS (1) DEPENDENCE TO DISSOLVED METALS STANDARD BY APPLICATION OF A CONVERSION FACTOR (CF).

Parameter	4-Day Average (Chronic) Concentration (UG/L)
CADMIUM	$CF * e^{(0.7409\ (\ln(\text{hardness}))\ -4.719}$ CF = 1.101672 - (In hardness) (0.041838)
CHROMIUM III	$CF * e^{(0.8190(\ln(\text{hardness}))\ +\ 0.6848}$ CF = 0.860
COPPER	$CF * e^{(0.8545(\ln(\text{hardness}))\ -1.702)}$ CF = 0.960
LEAD	$CF * e^{(1.273(\ln(\text{hardness}))-4.705)}$ CF = 1.46203 - (ln hardness)(0.145712)
NICKEL	$CF * e^{(0.8460(\ln(\text{hardness}))+0.0584)}$ CF = 0.997
SILVER	N/A
ZINC	$Cf * e^{(0.8473(\ln(\text{hardness}))+0.884)}$ CF = 0.986

TABLE 2.14.3b

EQUATIONS TO CONVERT TOTAL RECOVERABLE METALS STANDARD WITH HARDNESS (1) DEPENDENCE TO DISSOLVED METALS STANDARD BY APPLICATION OF A CONVERSION FACTOR (CF).

Parameter	1-Hour Average (Acute) Concentration (UG/L)
CADMIUM	$CF * e^{(1.0166(\ln(\text{hardness}))-3.924)}$ CF = 1.136672 - (ln hardness)(0.041838)
CHROMIUM (III)	$CF * e^{(0.8190(\ln(\text{hardness}))\ +3.7256)}$ CF = 0.316
COPPER	$CF * e^{(0.9422(\ln(\text{hardness}))-\ 1.700)}$ CF = 0.960
LEAD	$CF * e^{(1.273(\ln(\text{hardness}))-1.460)}$ CF = 1.46203 - (ln hardness)(0.145712)
NICKEL	$CF * e^{(0.8460(\ln(\text{hardness}))\ +2.255}$ CF= 0.998
SILVER	$CF * e^{(1.72(\ln(\text{hardness}))-\ 6.59}$ CF = 0.85

ZINC $CF * e^{(0.8473(\ln(\text{hardness})) + 0.884}$

$CF = 0.978$

FOOTNOTE:

(1) Hardness as mg/l $CaCO_3$.

TABLE 2.14.4
EQUATIONS FOR PENTACHLOROPHENOL
(pH DEPENDENT)

4-Day Average (Chronic) Concentration (UG/L)	1-Hour Average (Acute) Concentration (UG/L)
$e^{(1.005(pH))-5.134}$	$e^{(1.005(pH))-4.869}$

TABLE 2.14.5
SITE SPECIFIC CRITERIA FOR
DISSOLVED OXYGEN FOR JORDAN RIVER AND SURPLUS CANAL SEGMENTS
(SEE SECTION 2.13)

DISSOLVED OXYGEN:	
May-July	
7-day average	5.5 mg/l
30-day average	5.5 mg/l
Instantaneous minimum	4.5 mg/l
August-April	
30-day average	5.5 mg/l
Instantaneous minimum	4.0 mg/l

TABLE 2.14.6
LIST OF HUMAN HEALTH CRITERIA (CONSUMPTION)

Chemical Parameter	(ug/L) Class 1C	Water and Organism Organism Only (ug/L) Class 3A, 3B, 3C, 3D
Antimony	5.6	640
Arsenic	A	A
Beryllium	C	C
Cadmium	C	C
Chromium III	C	C
Chromium VI	C	C
Copper	1,300	
Lead	C	C
Mercury	A	A
Nickel	100 MCL	4,600
Selenium	A	4,200
Silver		
Thallium	0.24	0.47
Zinc	7,400	26,000
Cyanide	140	140

Asbestos	7 million Fibers/L	
2,3,7,8-TCDD Dioxin	5.0 E -9 B	5.1 E-9 B
Acrolein	190	290
Acrylonitrile	0.051 B	0.25 B
Alachlor	2.0	
Atrazine	3.0	
Benzene	2.2 B	51 B
Bromoform	4.3 B	140 B
Carbofuran	40	
Carbon Tetrachloride	0.23 B	1.6 B
Chlorobenzene	100 MCL	1,600
Chlorodibromomethane	0.40 B	13 B
Chloroethane		
2-Chloroethylvinyl Ether		
Chloroform	5.7 B	470 B
Dalapon	200	
Di(2ethylhexl)adipate	400	
Dibromochloropropane	0.2	
Dichlorobromomethane	0.55 B	17 B
1,1-Dichloroethane		
1,2-Dichloroethane	0.38 B	37 B
1,1-Dichloroethylene	7 MCL	7,100
Dichloroethylene (cis-1,2)	70	
Dinoseb	7.0	
Diquat	20	
1,2-Dichloropropane	0.50 B	15 B
1,3-Dichloropropene	0.34	21
Endothall	100	
Ethylbenzene	530	2,100
Ethylene Dibromide	0.05	
Glyphosate	700	
Haloacetic acids	60 E	
Methyl Bromide	47	1,500
Methyl Chloride	F	F
Methylene Chloride	4.6 B	590 B
Ocamyl (vidate)	200	
Picloram	500	
Simazine	4	
Styrene	100	
1,1,2,2-Tetrachloroethane	0.17 B	4.0 B
Tetrachloroethylene	0.69 B	3.3 B
Toluene	1,000	15,000
1,2 -Trans-Dichloroethylene	100 MCL	10,000
1,1,1-Trichloroethane	200 MCL	F
1,1,2-Trichloroethane	0.59 B	16 B
Trichloroethylene	2.5 B	30 B
Vinyl Chloride	0.025	2.4
Xylenes	10,000	
2-Chlorophenol	81	150
2,4-Dichlorophenol	77	2902,4-Dimethylphenol 380 850
2-Methyl-4,6-Dinitrophenol	13.0	280
2,4-Dinitrophenol	69	5,300

2-Nitrophenol			
4-Nitrophenol			
3-Methyl-4-Chlorophenol			
Penetachlorophenol	0.27 B		3.0 B
Phenol	21,000		1,700,000
2,4,6-Trichlorophenol	1.4 B		2.4 B
Acenaphthene	670		990
Acenaphthylene			
Anthracene	8,300		40,000
Benzidine	0.000086 B		0.00020 B
BenzoaAnthracene	0.0038 B		0.018 B
BenzoaPyrene	0.0038 B		0.018 B
BenzobFluoranthene	0.0038 B		0.018 B
BenzoghiPerylene			
BenzokFluoranthene	0.0038 B		0.018 B
Bis2-ChloroethoxyMethane			
Bis2-ChloroethylEther	0.030 B		0.53 B
Bis2-ChloroisopropylEther	1,400		65,000
Bis2-EthylhexylPhthalate	1.2 B		2.2 B
4-Bromophenyl Phenyl Ether			
Butylbenzyl Phthalate	1,500		1,900
2-Chloronaphthalene	1,000		1,600
4-Chlorophenyl Phenyl Ether			
Chrysene	0.0038 B		0.018 B
Dibenzoa, hAnthracene	0.0038 B		0.018 B
1,2-Dichlorobenzene	420		1,300
1,3-Dichlorobenzene	320		960
1,4-Dichlorobenzene	63		190
3,3-Dichlorobenzidine	0.021 B		0.028 B
Diethyl Phthalate	17,000		44,000
Dimethyl Phthalate	270,000		1,100,000
Di-n-Butyl Phthalate	2,000		4,500
2,4-Dinitrotoluene	0.11 B		3.4 B
2,6-Dinitrotoluene			
Di-n-Octyl Phthalate			
1,2-Diphenylhydrazine	0.036 B		0.20 B
Fluoranthene	130	140	
Fluorene	1,100		5,300
Hexachlorobenzene	0.00028 B		0.00029 B
Hexachlorobutedine	0.44 B		18 B
Hexachloroethane	1.4 B		3.3 B
Hexachlorocyclopentadiene	40		1,100
Ideno 1,2,3-cdPyrene	0.0038 B		0.018 B
Isophorone	35 B		960 B
Naphthalene			
Nitrobenzene	17		690
N-Nitrosodimethylamine	0.00069 B		3.0 B
N-Nitrosodi-n-Propylamine	0.005 B		0.51 B
N-Nitrosodiphenylamine	3.3 B		6.0 B
Phenanthrene			
Pyrene	830		4,000
1,2,4-Trichlorobenzene	35		70
Aldrin	0.000049 B		0.000050 B
alpha-BHC	0.0026 B		0.0049 B

beta-BHC	0.0091 B	0.017 B
gamma-BHC (Lindane)	0.2 MCL	1.8
delta-BHC		
Chlordane	0.00080 B	0.00081 B
4,4-DDT	0.00022 B	0.00022 B
4,4-DDE	0.00022 B	0.00022 B
4,4-DDD	0.00031 B	0.00031 B
Dieldrin	0.000052 B	0.000054 B
alpha-Endosulfan	62	89
beta-Endosulfan	62	89
Endosulfan Sulfate	62	89
Endrin	0.059	0.060
Endrin Aldehyde	0.29	0.30
Heptachlor	0.000079 B	0.000079 B
Heptachlor Epoxide	0.000039 B	0.000039 B
Polychlorinated Biphenyls PCB's	0.000064 B,D	0.000064 B,D
Toxaphene	0.00028 B	0.00028 B

Footnotes:

A. See Table 2.14.2

B. Based on carcinogenicity of 10-6 risk.

C. EPA has not calculated a human criterion for this contaminant. However, permit authorities should address this contaminant in NPDES permit actions using the State's existing narrative criteria for toxics

D. This standard applies to total PCBs.

KEY: water pollution, water quality standards
Date of Enactment or Last Substantive Amendment: June 1, 2005
Notice of Continuation: October 7, 2002
Authorizing, and Implemented or Interpreted Law: 19-5

APPENDIX B

CONSTRUCTION SCHEDULE

TENTATIVE CONSTRUCTION SCHEDULE
TONY M MINE

May 2007: Reconstruct Evaporation Pond Dam and Liner (finish)
~~Install Generators and Air Compressors~~
~~Install Fuel Tanks and MgCl2 Tanks~~
Install Permanent Mine Dewatering System

June 2007: Construct Permanent Diversion Channel
Construct Temporary drainage ditch & Sedimentation Basin
Construct Ore Slots
Construct Access Road for Ore Haulage

July 2007: Start Use of Waste Rock Area (WRA) and ore stockpile area
Construct Warehouse and Shop

~~April~~ **December** 2007: Install Temporary Mine Dewatering System (Vent Hole 3)
Install Temporary Trailers (Office, Dry, and Storage)
Rehabilitate Well and Septic System
Install Generators and Air Compressors
Install Fuel Tanks and MgCl2 Tanks

November 2007: Reconstruct Evaporation Pond Dam and Liner ~~(start)~~
~~Install Temporary Trailers (Office, Dry, and Storage)~~
~~Rehabilitate Well and Septic System~~

Summer 2008: **Install used oil above ground storage tank**

Notes:

1. ~~The Tentative Construction Schedule is based on receiving all required permits by the end of the first quarter, 2007.~~

2. Topsoil will be stripped immediately prior to construction in the areas that will be impacted.

APPENDIX C

BEST MANAGEMENT PRACTICES SPECIFICATION SHEETS

Riprap

Minimum Measure: Construction Site Stormwater Runoff Control

Subcategory: Erosion Control

Riprap can be used to stabilize drainageways and outlets to prevent erosion

Description

Riprap is a layer of large stones used to protect soil from erosion in areas of concentrated runoff. Riprap can also be used on slopes that are unstable because of seepage problems.

Applicability

Use riprap to stabilize cut-and-fill slopes; channel side slopes and bottoms; inlets and outlets for culverts, bridges, slope drains, grade stabilization structures, and storm drains; and streambanks and grades.

Siting and Design Considerations

Riprap can be unstable on very steep slopes, especially when rounded rock is used. For slopes steeper than 2:1, consider using materials other than riprap for erosion protection.

Consider the following design recommendations for riprap installation (Smolen et al., 1988):

Gradation. Use a well-graded mixture of rock sizes instead of one uniform size.

Quality of stone. Use riprap material that is durable so that freeze and thaw cycles do not decompose it in a short time; most igneous stones, such as granite, have suitable durability.

Riprap depth. Make the riprap layer at least two times as thick as the maximum stone diameter.

Filter material. Apply a filter material--usually a synthetic cloth or a layer of gravel--before applying the riprap. This prevents the underlying soil from moving through the riprap.

Riprap Limits. Place riprap so it extends to the maximum flow depth, or to a point where vegetation will be satisfactory to control erosion.

Curves. Ensure that riprap extends to five times the bottom width upstream and downstream of the beginning and ending of the curve and the entire curved section.

Riprap Size. The size of the riprap material depends on the shear stress of the flows the riprap will be subject to, but it ranges from an average size of 2 inches to 24 inches in diameter (Idaho Department of Environmental Quality, no date).

Wire Riprap Enclosures. Consider using chain link fencing or wire mesh to secure riprap installations, especially on steep slopes or in high flow areas.

Limitations

The steepness of the slope limits the applicability of riprap, because slopes greater than 2:1 can cause riprap loss due to erosion and sliding. If used improperly, riprap can actually increase erosion. In addition, riprap can be more expensive than other stabilization options.

Maintenance Considerations

Inspect riprap areas annually and after major storms. If riprap has been damaged, repair it promptly to prevent a progressive failure. If repairs are needed repeatedly at a location, evaluate the site to determine if the original design conditions have changed. Also, you might need to control weed and brush growth in some locations.

Effectiveness

When properly designed and installed, riprap can prevent erosion from the protected area.

Cost Considerations

The cost of riprap varies depending on location and the type of material selected. A cost of $35 to $50 per square yard of nongrouted riprap has been reported, while grouted riprap ranges from $45 to $60 per square yard (1993 dollars; Mayo et al., 1993).

References

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Idaho Department of Environmental Quality. No date. *Catalog of Stormwater BMPs for Cities and Counties: BMP #20 - Riprap Slope and Outlet Protection.* http://www.deq.state.id.us/water/data_reports/storm_water/stormwater_catalog_bmp20.pdf. Accessed May 10, 2006.

Mayo, L., D. Lehman, L. Olinger, B. Donavan, and P. Mangarella. 1993. *Urban BMP Cost and Effectiveness Summary Data for 6217(g) Guidance: Erosion and Sediment Control During Construction.* Woodward-Clyde Consultants.

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Smolen, M.D., D.W. Miller, L.C. Wyatt, J. Lichthardt, and A.L. Lanier. 1988. *Erosion and Sediment Control Planning and Design Manual.* North Carolina Sedimentation Control Commission; North Carolina Department of Environment, Health, and Natural Resources; and

Division of Land Resources Land Quality Section, Raleigh, NC.

SWRPC (Southeast Wisconsin Regional Planning Commission). 1991. *Costs of Urban Nonpoint Source Water Pollution Control Measures*. Technical Report No. 31. Southeast Wisconsin Regional Planning Commission, Waukesha, WI.

Mulching

Minimum Measure: Construction Site Stormwater Runoff Control

Subcategory: Erosion Control

Grass mulching is applied to stabilize exposed soils and to reduce stormwater runoff velocity

Description

Mulching is an erosion control practice that uses materials such as grass, hay, wood chips, wood fibers, straw, or gravel to stabilize exposed or recently planted soil surfaces. Mulching is highly recommended and is most effective when used in conjunction with vegetation. In addition to stabilizing soils, mulching can reduce stormwater velocity and improve the infiltration of runoff. Mulching can also aid plant growth by holding seeds, fertilizers, and topsoil in place, preventing birds from eating seeds, retaining moisture, and insulating plant roots against extreme temperatures.

Mulch matting is made from materials such as jute or other wood fibers that are formed into sheets and are more stable than loose mulch. Use jute and other wood fibers, plastic, paper, or cotton individually or combine them into mats to hold mulch to the ground. Use netting to stabilize soils while plants are growing; although, netting does not retain moisture or insulate against extreme temperatures. Mulch tackifiers made of asphalt or synthetic materials are sometimes used instead of netting to bind loose mulches.

Applicability

Mulching is often used in areas where vegetation cannot be established. Mulching can provide immediate and inexpensive erosion control. On steep slopes and critical areas, such as those near waterways, use mulch matting with netting or anchoring to hold it in place. Use mulches on seeded and planted areas where slopes are steeper than 2:1 or where sensitive seedlings require insulation from extreme temperatures or moisture retention.

Siting and Design Considerations

When possible, natural mulches should be used for erosion control and plant material establishment. Suggested materials include loose straw, netting, wood cellulose, or agricultural silage. All materials should be free of seed. Anchor loose hay or straw by applying tackifier, stapling netting over the top, or crimping with a mulch crimping tool. Materials that are heavy enough to stay in place (for example, gravel or bark or wood chips on flat slopes) do not need anchoring. Other examples of organic mulches include hydraulic mulch products with 100 percent post-consumer paper content, yard trimming composts, and wood mulch from recycled stumps and tree parts. Use inorganic mulches such as pea gravel or crushed granite in unvegetated areas.

Mulches may or may not require a binder, netting, or tacking. To ensure effective use of netting and matting material, keep firm, continuous contact between the materials and the soil. If there is no contact, the material will not hold the soil and erosion will occur underneath the material. Grading is not necessary before mulching. Use biodegradable netting, if possible.

There must be adequate coverage to prevent erosion, washout, and poor plant establishment. If an appropriate tacking agent is not applied, or is applied in insufficient amounts, mulch will be lost to wind and runoff. The channel grade and liner must be appropriate for the amount of runoff, or the channel bottom will erode. Also, apply hydromulch in spring, summer, or fall to prevent deterioration of mulch before plants can become established. Table 1 presents guidelines for installing mulches.

Table 1. Typical mulching materials and application rates

Material	Rate per acre	Requirements	Notes
Organic Mulches			
Straw	1 - 2 tons	Dry, unchopped, unweathered; avoid weeds	Spread by hand or machine; must be tacked or tied down
Wood fiber or wood cellulose	½ - 1 ton		Use with hydroseeder; may be used to tack straw; do not use in hot, dry weather
Wood chips	5 - 6 tons	Air dry; add fertilizer N, 12 lb/ton	Apply with blower, chip handler, or by hand; not for fine turf areas
Bark	35 yd^3	Air dry, shredded, or hammermilled, or chips	Apply with mulch blower, chip handler, or by hand; do not use asphalt tack
Nets and mats			
Jute net	Cover area	Heavy, uniform; woven of single jute yarn; use with organic mulch	Withstands water flow
Excelsior (wood	Cover area		

fiber) mat			
Fiberglass roving	½ - 1 ton	Continuous fibers of drawn glass bound together with a non-toxic agent	Apply with compressed air ejector; tack with emulsified asphalt at a rate of 25 - 35 gal/1000 ft^2

Limitations

Mulching, matting, and netting might delay seed germination because the cover changes soil surface temperatures. The mulches themselves are subject to erosion and may be washed away in a large storm. Maintenance is necessary to ensure that mulches provide effective erosion control.

Maintenance Considerations

Anchor mulches to resist wind displacement. When protection is no longer needed, remove netting and compost it or dispose of it in a landfill. Inspect mulched areas frequently to identify areas where it has loosened or been removed, especially after rainstorms. Reseed these areas, if necessary, and replace the mulch cover immediately. Apply mulch binders at rates recommended by the manufacturer. If washout, breakage, or erosion occurs, repair, reseed and remulch surfaces, and install new netting. Continue inspections until vegetation is firmly established.

Effectiveness

Mulching effectiveness varies according to the type of mulch used. Soil loss reduction for different mulches ranges from 53 to 99.8 percent. Water velocity reductions range from 24 to 78 percent. Table 2 shows soil loss and water velocity reductions for different mulch treatments.

Table 2. Measured reductions in soil loss for different mulch treatments (Source: Harding, 1990, as cited in USEPA, 1993)

Mulch characteristics	Soil loss reduction (%)	Water velocity reduction (% relative to bare soil)
100% wheat straw/top net	97.5	73
100% wheat straw/two nets	98.6	56
70% wheat straw/30% coconut fiber	98.7	71
70% wheat straw/30% coconut fiber	99.5	78
100% coconut fiber	98.4	77
Nylon monofilament/two nets	99.8	74
Nylon monofilament/rigid/bonded	53.0	24
Vinyl monofilament/flexible/bonded	89.6	32

Curled wood fibers/top net	90.4	47
Curled wood fibers/two nets	93.5	59
Antiwash netting(jute)	91.8	59
Interwoven paper and thread	93.0	53
Uncrimped wheat straw, 2,242 kg/ha	84.0	45
Uncrimped wheat straw, 4,484 kg/ha	89.3	59

Cost Considerations

Costs of seed and mulch average $1,500 per acre and range from $800 to $3,500 per acre (USEPA, 1993).

References

Harding, M.V. 1990. Erosion Control Effectiveness: Comparative Studies of Alternative Mulching Techniques. *Environmental Restoration*, pp. 149-156, as cited in USEPA. 1993. *Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters*. EPA 840-B-92-002. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

Smolen, M.D., D.W. Miller, L.C. Wyatt, J. Lichthardt, and A.L. Lanier. 1988. *Erosion and Sediment Control Planning and Design Manual*. North Carolina Sedimentation Control Commission; North Carolina Department of Environment, Health, and Natural Resources; and Division of Land Resources Land Quality Section, Raleigh, NC.

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Seeding

Minimum Measure: Construction Site Stormwater Runoff Control

Subcategory: Erosion Control

Hydroseeding is a popular technique for applying seeds, fertilizer, and chemical stabilizers in a single application (Source: Terra Firma Industries, 2000)

Description

Seeding is used to control runoff and erosion on disturbed areas by establishing perennial vegetative cover from seed. It reduces erosion and sediment loss and provides permanent stabilization. This practice is economical, adaptable to different site conditions, and allows selection of a variety of plant materials.

Applicability

Seeding is well-suited in areas where permanent, long-lived vegetative cover is the most practical or most effective method of stabilizing the soil. Use seeding on roughly graded areas that will not be regraded for at least a year. Vegetation controls erosion by protecting bare soil surfaces from displacement by raindrop impacts and by reducing the velocity and quantity of overland flow. Seeding's advantages over other means of establishing plants include lower initial costs and labor needs.

Siting and Design Considerations

Seed or plant permanent vegetation in areas 1 to 4 months after the final grade is achieved unless temporary stabilization measures are in place. Maximize successful plant establishment with planning; considering soil characteristics; selecting plant materials that are suitable for the site; preparing, liming, and fertilizing the seedbed adequately; planting timely; and maintaining regularly. Major factors that dictate the suitability of plants for a site include climate, soils, and topography. Prepare and amend the soil on a disturbed site to provide sufficient nutrients for seed germination and seedling growth. Loosen the soil surface enough for water infiltration and root

penetration. If soils are too acidic, increase the pH to between 6.0 and 6.5 with liming or choose plants that are appropriate for the soil characteristics at your site. Protect seeds with mulch to retain moisture, regulate soil temperatures, and prevent erosion during seedling establishment.

Limitations

The effectiveness of seeding can be limited by high erosion during establishment, the need to reseed areas that fail to establish, limited seeding times, or unstable soil temperature and soil moisture content during germination and early growth. Seeding does not immediately stabilize soils; therefore, use temporary erosion and sediment control measures to prevent pollutants from disturbed areas from being transported off the site.

Maintenance Considerations

Maintenance for seeded areas will vary depending on the level of use expected. Use long-lived grass perennials that form a tight sod and are fine-leaved for areas that receive extensive use, such as homes, industrial parks, schools, churches, and recreational areas. Whenever possible, choose native species that are adapted to local weather and soil conditions to reduce water and fertilizer inputs and lower maintenance overall. In arid areas, consider seeding with non-grass species that are adapted to drought conditions, called xeriscaping, to reduce the need for watering.

Low-maintenance areas are mowed infrequently or not at all and do not receive lime or fertilizer regularly. Plants must be able to persist with minimal maintenance over long periods of time. Use grass and legume mixtures for these sites because legumes fix nitrogen from the atmosphere. Sites suitable for low-maintenance vegetation include steep slopes, stream or channel banks, some commercial properties, and "utility" turf areas such as road banks.

Grasses should emerge within 4-28 days and legumes 5-28 days after seeding, with legumes following grasses. A successful stand has the following characteristics:

Vigorous dark green or bluish green (not yellow) seedlings
Uniform density, with nurse plants, legumes, and grasses well intermixed
Green leaves that remain green throughout the summer--at least at the plant bases

Inspect seeded areas for failure and, if needed, reseed and repair them as soon as possible. If a stand has inadequate cover, reevaluate the choice of plant materials and quantities of lime and fertilizer. Depending on the condition of the stand, repair by overseeding or reseeding after complete seedbed preparation. If timing is bad, overseed with rye grain or German millet to thicken the stand until a suitable time for seeding perennials. Consider seeding temporary, annual species if the season is not appropriate for permanent seeding. If vegetation fails to grow, test the soil to determine if low pH or nutrient imbalances are responsible.

On a typical disturbed site, full plant establishment usually requires refertilization in the second growing season. Use soil tests to determine if more fertilizer needs to be added. Do not fertilize cool season grasses in late May through July. Grass that looks yellow might be nitrogen deficient. Do not use nitrogen fertilizer if the stand contains more than 20 percent legumes.

Effectiveness

Perennial vegetative cover from seeding has been shown to remove between 50 and 100 percent of total suspended solids from stormwater runoff, with an average removal of 90 percent (USEPA,

1993).

Cost Considerations

Seeding costs range from $200 to $1,000 per acre and average $400 per acre. Maintenance costs range from 15 to 25 percent of initial costs and average 20 percent (USEPA, 1993).

References

FHWA (Federal Highway Administration). 1995. *Best Management Practices for Erosion and Sediment Control*. FHWA-SLP-94-005. Federal Highway Administration, Sterling, VA.

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Soil Roughening

Minimum Measure: Construction Site Stormwater Runoff Control

Subcategory: Erosion Control

Exposed soils can be temporarily stabilized by driving a tractor over the surface

Description

Soil roughening is a temporary erosion control practice often used in conjunction with grading. Soil roughening involves increasing the relief of a bare soil surface with horizontal grooves by either stair-stepping (running parallel to the contour of the land) or using construction equipment to track the surface. Slopes that are not fine graded and left in a roughened condition can also reduce erosion. Soil roughening reduces runoff velocity, increases infiltration, reduces erosion, traps sediment, and prepares the soil for seeding and planting by giving seed an opportunity to take hold and grow.

Applicability

Soil roughening is appropriate for all slopes, but works especially well on slopes greater than 3:1, on piles of excavated soil, and in areas with highly erodible soils. This technique is especially appropriate for soils that are frequently disturbed, because roughening is relatively easy. To slow erosion, roughen the soil as soon as possible after the vegetation has been removed from the slope or immediately after grading activities have ceased (temporarily or permanently). Use this practice in conjunction with seeding, planting, and temporary mulching to stabilize an area. A combination of surface roughening and vegetation is appropriate for steeper slopes and slopes that will be left bare for longer periods of time.

Siting and Design Considerations

Roughened slope surfaces help establish vegetation, improve infiltration, and decrease runoff velocity. A rough soil surface allows surface ponding that protects lime, fertilizer, and seed and decreases erosion potential. Grooves in the soil are cooler and provide more favorable moisture conditions than hard, smooth surfaces. These conditions promote seed germination and

vegetative growth.

Avoid excessive soil compacting, because this inhibits vegetation growth and causes higher runoff velocity. Limit roughening with tracked machinery to sandy soils that do not compact easily; also, avoid tracking on heavy clay soils, especially when wet. Seed roughened areas as quickly as possible, and follow proper dust control procedures.

Depending on the type of slope and the available equipment, use different methods for roughening soil on a slope. These include stair-step grading, grooving, and tracking. When choosing a method, consider factors such as slope steepness, mowing requirements, whether the slope is formed by cutting or filling, and available equipment. Choose from the following methods for surface roughening:

Cut slope roughening for areas that will not be mowed. Use stair-step grades or groove-cut slopes for gradients steeper than 3:1. Use stair-step grading on any erodible material that is soft enough to be ripped with a bulldozer. Also, it is well suited for slopes consisting of soft rock with some subsoil. Make the vertical cut distance less than the horizontal distance, and slope the horizontal portion of the step slightly toward the vertical wall. Keep individual vertical cuts less than 2 feet deep in soft materials and less than 3 feet deep in rocky materials.

Grooving. This technique uses machinery to create a series of ridges and depressions that run across the slope along the contour. Make grooves using any appropriate implement that can be safely operated on the slope, such as disks, tillers, spring harrows, or the teeth on a front-end loader bucket. Make the grooves less than 3 inches deep and less than 15 inches apart.

Fill slope roughening for areas that will not be mowed. Fill slopes with a gradient steeper than 3:1 should be placed in lifts less than 9 inches, and properly compact each lift. The face of the slope should consist of loose, uncompacted fill 4 to 6 inches deep. If necessary, roughen the face of the slopes by grooving the surface as described above. Do not blade or scrape the final slope face.

Cuts, fills, and graded areas that will be mowed. Make mowed slopes no steeper than 3:1. Roughen these areas with shallow grooves less than 10 inches apart and deeper than 1 inch using normal tilling, disking, or harrowing equipment (a cultipacker-seeder can also be used). Excessive roughness is undesirable where mowing is planned.

Roughening with tracked machinery. To avoid undue compaction of the soil surface, limit roughening with tracked machinery only to sandy soils. Operate tracked machinery perpendicularly to the slope to leave horizontal depressions in the soil. Tracking is generally not as effective as other roughening methods.

Limitations

Soil roughening is not appropriate for rocky slopes. Tracked machinery can excessively compact the soil. Typically, soil roughening is effective only for gentle or shallow depth rains. If roughening is washed away in a heavy storm, re-roughen the surface and reseed.

Maintenance Considerations

Inspect roughened areas after storms to see if re-roughening is needed. Regular inspection should indicate where additional erosion and sediment control measures are needed. If rills (small watercourses that have steep sides and are usually only a few inches deep) appear, fill, regrade, and reseed them immediately. Use proper dust control methods.

Effectiveness

Soil roughening provides moderate erosion protection for bare soils while vegetative cover is

being established. It is inexpensive and simple for short-term erosion control when used with other erosion and sediment controls.

Cost Considerations

Soil roughening requires minimal materials but requires using heavy equipment.

References

Smolen, M.D., D.W. Miller, L.C. Wyatt, J. Lichthardt, and A.L. Lanier. 1988. *Erosion and Sediment Control Planning and Design Manual*. North Carolina Sedimentation Control Commission; North Carolina Department of Environment, Health, and Natural Resources; and Division of Land Resources, Land Quality Section, Raleigh, NC.

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Grass-Lined Channels

Minimum Measure: Construction Site Stormwater Runoff Control

Subcategory: Runoff Control

A grass-lined channel can be used to filter and convey runoff

Description

A grass-lined channel conveys stormwater runoff through a stable conduit. Vegetation lining the channel slows down concentrated runoff. Because grassed channels are not usually designed to control peak runoff loads by themselves, they are often used with other BMPs, such as subsurface drains and riprap stabilization.

Where moderately steep slopes require drainage, grassed channels can include excavated depressions or check dams to enhance runoff storage, decrease flow rates, and improve pollutant removal. Peak discharges can be reduced by temporarily holding them in the channel. Pollutants can be removed from stormwater by filtration through vegetation, by deposition, or in some cases by infiltration of soluble nutrients into the soil. The degree of pollutant removal in a channel depends on how long the water stays in the channel and the amount of contact with vegetation and the soil surface. Local conditions affect the removal efficiency.

Applicability

The first choice of lining should be grass or sod because this reduces runoff velocity and provides water quality benefits through filtration and infiltration. If the velocity in the channel would erode the grass or sod, riprap, concrete, or gabions can be used (USEPA, 2004). Geotextile materials can be used in conjunction with either grass or riprap linings to provide additional protection at the soil-lining interface. Use grassed channels in areas where erosion-resistant conveyances are needed, including areas with highly erodible soils and moderately steep slopes (though less than 5 percent). Install them only where space is available for a relatively large cross section. Grassed channels have a limited ability to control runoff from large storms, so do not use them in areas where flow rates exceed 5 feet per second.

Siting and Design Considerations

Site grass-lined channels in accordance with the natural drainage system. They should not cross ridges. The channel design should not have sharp curves or significant changes in slope. The channel should not receive direct sedimentation from disturbed areas and should be sited only on the perimeter of a construction site to convey relatively clean stormwater runoff. To reduce sediment loads, separate channels from disturbed areas by using a vegetated buffer or another BMP.

Basic design recommendations for grassed channels include the following:

Construct and vegetate the channel before grading and paving activities begin.
Make sure design velocities are less than 5 feet per second.
Consider using geotextiles to stabilize vegetation until it is fully established.
Consider covering the bare soil with sod, mulches with netting, or geotextiles to provide reinforced stormwater conveyance immediately.
Use triangular channels with low velocities and small quantities of runoff; use parabolic grass channels for larger flows and where space is available; use trapezoidal channels with large, low-velocity flows (low slope).
Install outlet stabilization structures if the runoff volume or velocity might exceed the capacity of the receiving area.
Slope the sides of the channel less than 2:1; slope triangular channels along roads 2:1 or less for safety.
Remove all trees, brushes, stumps, and other debris during construction.

Effectiveness

Grass-lined channels can effectively transport stormwater from construction areas if they are designed for expected flow rates and velocities and if they do not receive sediment directly from disturbed areas.

Limitations

If grassed channels are not properly installed, they can change the natural flow of surface water and adversely affect downstream waters. And if the design capacity is exceeded by a large storm event, the vegetation might not be adequate to prevent erosion and the channel might be destroyed. Clogging with sediment and debris reduces the effectiveness of grass-lined channels for stormwater conveyance.

Maintenance Considerations

The maintenance requirements for grass channels are relatively minimal. While vegetation is being established, inspect the channels after every rainfall. After vegetation is established, mow it, remove litter, and perform spot vegetation repair. The most important objective in grassed channel maintenance is to maintain a dense and vigorous growth of turf. Periodically clean the vegetation and soil buildup in curb cuts so that water flow into the channel is unobstructed. During the growing season, cut the channel grass no shorter than the level of the design flow.

Cost Considerations

Costs of grassed channels range according to depth. The cost of a 1.5-foot-deep grassed channel with 3:1 side slopes and a 2-foot-wide channel bottom is estimated to cost between $202

and $625 per 100 feet of channel length. The cost of a 3-foot-deep grassed channel with 3:1 side slope adn a 2-foot-wide bottom is expected to cost between $397 and $1,198 for 100 feet of channel (SEWRPC, 1991). Grassed channels can be left in place permanently after the construction site is stabilized to contribute to long-term stormwater management. The channels, in combination with other practices that detain, filter, and infiltrate runoff, can substantially reduce the size of permanent detention facilities like stormwater ponds and wetlands, thereby reducing the overall cost of stormwater management.

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Permanent Slope Diversions

Minimum Measure: Construction Site Stormwater Runoff Control

Subcategory: Runoff Control

Description

Permanent slope diversions are designed to transport runoff down a slope in a manner that minimizes the potential for erosion. Diversions can be constructed by creating channels laterally across slopes to intercept the down-slope flow of runoff. The channels have a supporting earthen ridge on the bottom sides to reduce slope length, collect stormwater runoff, and deflect the runoff to outlets that convey it without causing erosion.

Applicability

Diversions should be considered for use on slopes where uncontrolled runoff might cause property damage due to erosion or resulting sedimentation. They can also be used to promote the growth of vegetation by redirecting flows while the vegetation is becoming established.

Siting and Design Considerations

A properly designed earthen ridge typically has side slopes no steeper than 2:1, a width at the design water elevation of at least 4 feet, a minimum freeboard of 0.3 foot, and a 10 percent settlement factor included in the design (reference?).

A stormwater conveyance channel can be vegetated or hardened (e.g., with rock or concrete). Both types should be sufficient in shape and size to carry stormwater runoff away from developing areas without any erosion damage. Paved flumes are not recommended unless very high flows with excessive erosive power are expected because faster runoff might exacerbate erosion at the flume's outfall. Paved flumes also prevent surface runoff from infiltrating, which can cause increased volumes and erosive forces of the runoff that leaves the site. Adequate outfall protection should be provided to prevent damage from the discharge of high-velocity flows. Where possible, vegetated channels should be used to minimize flow velocity and to enhance pollutant removal. Riprap, gabions, or turf reinforcement mats can provide additional channel stabilization.

The following are general specifications required for channel construction:

Remove all obstructions and unsuitable material, such as trees, roots, brush, and stumps, and any excess soil from the channel area and dispose of them properly.

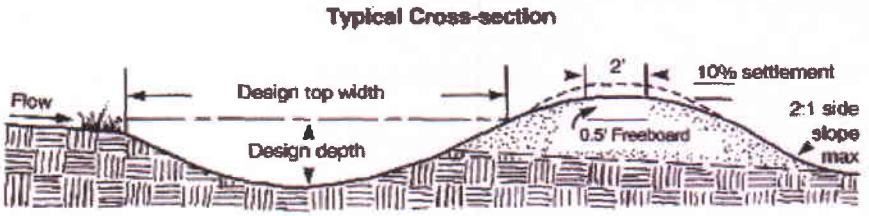
Make sure the channel meets grade and cross section specifications, and compact any fill used to ensure equal settlement.

Parabolic and triangular, grass-lined channels should not have a top width of more than 30 feet.

Trapezoidal, grass-lined channels may not have a bottom width of more than 15 feet unless there are multiple or divided waterways, they have a riprap center, or other methods of controlling the meandering of low flows are provided.

If grass-lined channels have a base flow, provide a stone center or subsurface drain or

another method for managing the base flow.



Site planners incorporate diversions into the overall grading plan to direct clean runoff away from exposed areas

All channels must have outlets that are protected from erosion. Locate structurally lined aprons or other appropriate energy-dissipating devices at channel outlets to slow stormwater flows and prevent scouring at stormwater outlets, protect the outlet structure, and minimize the erosion potential downstream. Construction specifications for outlet protection practices require the following:

No bends occur in the horizontal alignment.

There is no slope along the length of the apron, and the invert elevations are equal at the receiving channel and the apron's downstream end.

No overfall at the end of the apron is allowed.

If a pipe discharges into a well-defined channel, the channel's side slopes may not be steeper than 2:1.

The apron is lined with riprap, grouted riprap, concrete, or gabion baskets; all riprap conforms to standards and specifications; and the median-sized stone for riprap is specified in the plan.

Filter cloth, conforming to standards and specifications, must be placed between riprap and the underlying soil to prevent any soil movement through the riprap.

All grout for grouted riprap must be one part Portland cement for every three parts sand, mixed thoroughly with water. Once stones are in place, the spaces between them are to be filled with grout to a minimum depth of 6 inches, with the deeper portions choked with fine material.

All concrete aprons must be installed as specified in the plan.

The end of the paved channel in a paved channel outlet must be smoothly joined with the receiving channel section, with no overfall at the end of the paved section.

Limitations

Immediately after constructing a vegetated ridge and channel, seed and mulch them along with any disturbed areas that drain into the diversion. To prevent soil from moving into the diversion, sediment-trapping measures must remain in place in case the upslope area is not stabilized. Remove all obstructions and unsuitable material, such as trees, brush, and stumps, from the channel area and dispose of them so the diversion can function properly. The channel must meet grade and cross section specifications. Make sure any fill used is free from excessive organic debris, rocks, or other unsuitable material. Compact the fill to ensure equal settlement. Permanently stabilize disturbed areas according to applicable local standards and specifications. Stabilize the area around the channel that is disturbed by channel construction so that it is not subject to erosion similar to that of the slope the channel is built to protect.

Maintenance Considerations

Inspect diversions after every rainfall and at least once every 2 weeks before final stabilization.

Clear channels of sediment, make repairs when necessary, and reseed seeded areas if a vegetative cover is not established.

Costs

Costs of slope drains vary based on pipe (material) selection, length, and the outlet protection that is used. Supplied and installed costs (not inlcuding trenching) for corregated steel pipe ranges from less than $20 per linear foot for 12" pipe to more than $50 per linaer foot for 3o" pipe and from less than $25 per linear foot to $130 per linear foot (also supplied and installed, exclusing trenching) for PVC pipe (CASQA Handbook)

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Temporary Diversion Dikes

Minimum Measure: Construction Site Stormwater Runoff Control

Subcategory: Runoff Control

Diversion dikes can be used to contain stormwater onsite

Description

An earthen perimeter control usually consists of a dike or a combination dike and channel constructed along the perimeter of and within the disturbed part of a site. An earthen perimeter control is a ridge of compacted soil, often accompanied by a ditch or swale with a vegetated lining, at the top or base of a sloping disturbed area. Depending on its location and the topography of the landscape, an earthen perimeter control can achieve one of two goals.

When on the upslope side of a site, earthen perimeter controls help to prevent surface runoff from entering a disturbed construction site. An earthen structure located upslope can improve working conditions on a construction site. It can prevent an increase in the total amount of sheet flow runoff traveling across the disturbed area and thereby lessen erosion on the site.

Earthen perimeter control structures also can be located on the downslope side of a site. They divert sediment-laden runoff created onsite to onsite sediment-trapping devices, preventing soil loss from the disturbed area.

These control practices are called temporary diversion dikes, earth dikes, and interceptor dikes. No matter what they are called,, all earthen perimeter controls are constructed in a similar way with a similar objective--to control the velocity or route (or both) of sediment-laden stormwater runoff.

Applicability

Temporary diversion dikes apply where it is desirable to divert flows away from disturbed areas such as cut or fill slopes and to divert runoff to a stabilized outlet (USEPA, 1992). The dikes can

be erected at the top of a sloping area or in the middle of a slope to divert stormwater runoff around a disturbed construction site. In this way, earth dikes can be used to reduce the length of the slope across which runoff travels, reducing the erosion potential of the flow. If diversion dikes are placed at the bottom of a sloping disturbed area, they can divert flow to a sediment-trapping device. Temporary diversion dikes are usually appropriate for drainage basins smaller than 5 acres. With modifications they can service areas as large as 10 acres. With regular maintenance, earthen diversion dikes have a useful life span of about 18 months.

To prevent stormwater runoff from entering a site, earthen perimeter controls can be used to divert runoff from areas upslope around the disturbed construction site. A continuous, compacted earthen mound is constructed along the upslope perimeter of the site. As an additional control measure, a shallow ditch can accompany the earthen mound.

Siting and Design Considerations

The siting of earthen perimeter controls depends on the topography of the area surrounding the construction site. Another factor is whether the goal is to prevent sediment-laden runoff from entering the site or to keep stormwater runoff from leaving the site. When determining the appropriate size and design of earthen perimeter controls, consider the shape and drainage patterns of the surrounding landscape. Also consider the amount of runoff to be diverted, the velocity of runoff in the diversion, and the erodibility of soils on the slope and in the diversion channel or swales (WA State Dept. of Ecology, 2005).

Construct diversion dikes and fully stabilize them before any major land disturbance begins. This approach makes the diversion measure effective as an erosion and sediment control device.

The top of earthen perimeter controls designed as temporary flow diversion measures should be at least 2 feet wide. The bottom width at ground level is typically 6 feet. The minimum height for earth dikes should be 18 inches, with side slopes no steeper than 2:1. At points where vehicles will cross the dike, make sure the slope is no steeper than 3:1 and make the mound gravel rather than soil. This design makes the dike last longer and strengthens the point of vehicle crossing.

If a channel is excavated along the dike, its shape can be parabolic, trapezoidal, or V-shaped. Before any excavating or mound-building, remove all trees, brush, stumps, and other objects in the path of the diversion structure. Till the base of the dike before laying the fill. The maximum design flow velocity should range from 1.5 to 5.0 feet per second, depending on the vegetative cover and soil texture.

Most earthen perimeter structures are designed for short-term, temporary use. If the expected life span of the structure is more than 15 days, seed the earthen dike and the accompanying ditchwith vegetation immediately after construction. This increases the stability of the perimeter control and can decrease the need for frequent repairs and maintenance.

Limitations

Earth dikes are an effective means of diverting sediment-laden stormwater runoff around a disturbed area. But the concentrated runoff in the channel or ditch has increased erosion potential. Direct diversion dikes to sediment-trapping devices, where sediment can settle out of the runoff before it is discharged to surface waters. Sediment-trapping devices that work with temporary diversion structures include sediment basins, sediment chambers/filters, and any other structures designed to allow sediment to be collected for proper disposal.

If a diversion dike crosses a vehicle roadway or entrance, its effectiveness can be reduced. When

possible, design diversion dikes to avoid crossing vehicle pathways.

Maintenance Considerations

Inspect earthen diversion dikes after each rainfall to ensure continued effectiveness. Maintain dikes at their original height. Repair any decrease in height due to settling or erosion immediately. To remain effective, earth dikes must be compacted at all times. Regardless of rainfall frequency, inspect dikes at least once every 2 weeks for evidence of erosion or deterioration.

Effectiveness

When properly placed and maintained, earth dikes used as temporary diversions can control the velocity and direction of stormwater runoff. Used by themselves, they do not have any pollutant removal capability. They must be used with an appropriate sediment-trapping device at the outfall of the diversion channel.

Cost Considerations

The cost of constructing an earth dike can be broken down into two components: (1) site preparation (including excavation, placement, and compacting of fill) and grading, and (2) site development, including topsoiling and seeding for vegetative cover. The Southeastern Wisconsin Regional Planning Commission (1991) estimated the total cost of site preparation to be $46.33 to $124.81 for a 100-foot dike with 1.5-foot-deep, 3:1 side slopes. The cost of site development was estimated at $115.52 to $375.44. The total cost was between $162 and $500. The cost for constructinig diversion berms range from $15 to $55 per ft for both earthwork and stabilization and depends on the availability of suitable material, site location, and access. Small dikes range from $2.50 to $6.50 per linear ft and large dikes cost about $2.50 per cubic yard of earth (CASQA, 2003).

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Preserving Natural Vegetation

Minimum Measure: Construction Site Stormwater Runoff Control

Subcategory: Construction Site Planning and Management

Natural vegetation is protected from heavy equipment with safety fencing

Description

The principal advantage of preserving natural vegetation is protecting desirable trees, vines, bushes, and grasses from damage during project development. Vegetation provides erosion control, stormwater detention, biofiltration, and aesthetic values to a site during and after construction activities. Other benefits of preserving natural areas are because natural vegetation

Can process higher quantities of stormwater runoff than newly seeded areas
Does not require time to establish
Has a higher filtering capacity than newly planted vegetation because above ground and root structures are typically denser and using living root systems helps to hold soil in place
Reduces stormwater runoff by intercepting rainfall, protecting soil surface from the impact of raindrops, holding soil particles in place, maintaining the soil's capacity to absorb water, promoting infiltration, and lowering the water table through transpiration
Provides buffers and screens against noise and visual disturbance
Provides a fully developed habitat for wildlife
Usually requires less maintenance (e.g., irrigation, fertilizer) than planting new vegetation
Enhances aesthetics

Applicability

Preserving natural vegetation is applicable to all construction sites where vegetation exists in the predevelopment condition. The practice can be especially beneficial for floodplains, wetlands, stream banks, steep slopes, and other areas where erosion controls would be difficult to establish, install, or maintain. Clear only the land needed for building activities and vehicle traffic.

Siting and Design Considerations

Designers should be aware of and respond to local the climate and other conditions, including project scheduling, that may influence the use of natural vegetative stabilization measures. Before clearing activities begin, clearly mark the vegetation that is to be preserved. Prepare a site map with the locations of trees and boundaries of environmentally sensitive areas and buffer zones to be preserved. Plan the location of roads, buildings, and other structures to avoid these areas. This requires careful site management to minimize the impact of construction activities on existing vegetation. Protect large trees near construction zones because damage during construction activities could result in reduced vigor or death after construction has ceased. Extend and mark the boundaries around contiguous natural areas and tree drip lines to protect the root zone from damage. Obviously, direct contact by equipment damages trees and other vegetation, but compaction, filling, or excavating land too closely to the vegetation also can cause severe damage.

When selecting trees for preservation, consider the following factors:

Tree vigor. Preserve healthy trees that will be less susceptible to damage, disease, and insects. Indicators of poor vigor include dead tips of branches, stunted leaf growth, sparse foliage, and pale foliage color. Hollow, rotten, split, cracked, or leaning trees also have a lesser chance of survival.

Tree age. Choose older trees because they are more aesthetically pleasing as long as they are healthy.

Tree species. Preserve species that are well-suited to present and future site conditions. Keeping a mixture of evergreens and hardwoods can help to conserve energy--specifically, keeping evergreens on the northern side of the site to protect against cold winter winds and keeping deciduous trees on the southern side to provide shade in the summer and sunshine in the winter.

Wildlife benefits. Choose trees that are preferred by wildlife for food, cover, and nesting.

Other considerations include following natural contours and maintaining preconstruction drainage patterns. Changing the hydrology might kill preserved vegetation because their environmental requirements are no longer met.

The following are basic considerations for preserving natural vegetation:

Do not nail boards to trees during building operations.

Do not cut tree roots inside the tree drip line.

Use barriers to prevent equipment from approaching protected areas.

Keep equipment, construction materials, topsoil, and fill dirt outside the limit of preserved areas.

If a tree or shrub that is marked for preservation is damaged, remove and replace it with a tree of the same or similar species with a 2-inch or larger caliper width from balled and burlaped nursery stock when construction activity is complete.

During final site cleanup, remove barriers from around preserved areas and trees.

Limitations

Preserving vegetation is limited by the extent of existing vegetation in preconstruction conditions. It requires planning to preserve and maintain the existing vegetation. It is also limited by the size of the site relative to the size of structures to be built. High land prices might prohibit preservation of natural areas. Additionally, equipment must have enough room to maneuver; in some cases, preserved vegetation might block equipment traffic and can constrict the area available for

construction activities. Finally, if grading is not done properly, it could result in changes in environmental conditions that kill vegetation. Consider the hydrology of natural or preserved areas when planning the site.

Maintenance Considerations

Even if workers take precautions, some damage to protected areas might occur. If this happens, repair or replace damaged vegetation immediately to maintain the integrity of the natural system. When planning for new vegetation, choose kinds that enhance the existing vegetation. Ensure that new structures do not harm protected areas. If fertilization is needed, use the following practices to minimize adverse water quality affects:

Apply fertilizers at the minimum rate and to the minimum area needed.
Work the fertilizer deeply into the soil to reduce exposure of nutrients to stormwater runoff.
Apply fertilizer at lower application rates with a higher application frequency.
Limit hydroseeding, which is simultaneously applying lime and fertilizers.
Ensure that erosion and sediment controls are in place to prevent fertilizers and sediments from being transported offsite.

Effectiveness

Natural vegetation (existing trees, vines, brushes, and grasses) can provide water quality benefits by intercepting rainfall, filtering stormwater runoff, and preventing sediments and other pollutants from leaving the site.

Cost Considerations

Preserving natural vegetation could require additional labor to maneuver around trees or protected areas.

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Straw or Hay Bales

Minimum Measure: Construction Site Stormwater Runoff Control

Subcategory: Sediment Control

Description

Straw or hay bales have historically been used on construction sites for erosion and sediment control as check dams, inlet protection, outlet protection, and perimeter control. Many applications of straw bales for erosion and sediment control are proving ineffective due to the nature of straw bales, inappropriate placement, inadequate installation, or a combination of all three factors (Fifeld, 1999). In addition, straw bales are maintenance-intensive and can be expensive to purchase. Because many applications of straw and hay bales have been ineffective, EPA recommends that other BMP options are carefully considered. This fact sheet provides more information and options for alternatives to straw and hay bales.

Limitations

Straw bales cannot be used to reduce erosion in a drainage channel because if a straw bale structure is installed across the channel, the cross-sectional area is reduced, resulting in increased velocity of stormwater flow (IECA, 2005). This would lead to increased erosion around the bales, widening the channel's cross-section.

Straw bales do not work well in areas with heavy rain or on sites with large drainage areas or steep slopes. Straw bales should never be used on streets or sidewalks as they cannot be properly staked into concrete or asphalt and will float away.

Straw bales are very impermeable and are not able to withstand high flows, and care must be taken during placement and installation to avoid failure from undercutting, overtopping, and end-running. USDA NRCS (no date) states that water depth should never exceed 1 foot at any one time and straw bale structures should never be installed across streams, ditches, or where flow is concentrated because they can exacerbate erosion and flooding.

Straw bale installations have a high failure rate. According to some erosion control experts, straw bale installations are seldom designed, installed, and maintained properly (Fifeld, 1999). In addition, straw bales are difficult to transport and to carry around on-site, especially when attempting to dispose of them when they are waterlogged. Oftentimes, the bindings break and the straw can wash into storm drains, causing clogging.

Straw bales will rot and fall apart over time, especially in areas of high rainfall, and therefore require intensive maintenance; they only last for approximately three months. Straw bales will float and therefore must be properly staked even in low flow conditions. As previously stated, in high flow conditions, the water will flow around a straw bale barrier or undercut spaces between the bales.

Another factor to consider is that straw bales may introduce undesirable non-native plants to the

area if there are seeds in the bales.

Alternatives

The following is a list of typical applications for straw and hay bales and some alternative practices that have proven to be more effective.

Common uses of straw or hay bales	Alternative to straw or hay bales
Perimeter controls	Silt fence
Check dams	Rock check dams Fiber Rolls
Slope protection	Geotextiles Compost blankets
Storm drain inlet protection	Filter fabric, gravel bags, and other designs
Concrete washout structures	Prefabricated concrete washout containers

Considerations

If straw bales are used (only in limited circumstances), each bale should be a minimum of 14 inches wide, 18 inches high, 36 inches long and should have a minimum mass of 50 pounds. The straw bale should be composed entirely of vegetative matter except for the binding material. Bales should be bound by steel wire or nylon or polypropylene string. Jute and cotton binding should not be used. Baling wire should be a minimum 14-gauge diameter. Nylon or polypropylene string should be approximately 12-gauge in diameter with a breaking strength of 80 pounds of force. Wood stakes should be commercial quality lumber that is free from decay, splits, or cracks longer than the thickness of the stake, or other defects that would weaken the stakes and cause them to be structurally unsuitable. Steel bar reinforcement should be equal to a #4 designation or greater. End protection should be provided for any exposed bar reinforcement.

Maintenance Considerations

Straw bales degrade, and rotting bales will need to be replaced on a regular basis (as often as every 3 months depending on local conditions). Erosion from washouts around the bales will need to be repaired. Sediment that settles in ponded areas around correctly installed bales will need to be cleaned out when the sediment accumulation reaches one-third of the bale height. Straw bales will also have to be removed when they burst open or are no longer needed.

Effectiveness

Straw bale barriers have not been as effective as expected due to improper use, such as if they are placed incorrectly in drainageways where runoff volumes and velocities have caused the barriers to wash out. In addition, failure to stake and entrench the straw bale has allowed undercutting and end flow.

Often straw bale barriers will fill to capacity after small storms and can be washed away if not staked correctly. Straw bale structures cannot be designed for large storms and tend to fail during large runoff events.

Cost Considerations

Straw bales cost $5 to $7 each, or $9 to $15 per bale installed ($3 - $5 per linear foot). This does not include labor or material costs associated with maintenance.

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Dust Control

Minimum Measure: Construction Site Stormwater Runoff Control

Subcategory: Erosion Control

Dust control measures can be used to prevent dust from being transported by wind (Source: Dust Pro, Inc., no date)

Description

Dust control BMPs reduce surface activities and air movement that causes dust to be generated from disturbed soil surfaces. Construction sites can generate large areas of soil disturbance and open space for wind to pick up dust particles. Limited research at construction sites has established an average dust emission rate of 1.2 tons/acre/month for active construction (WA Dept. of Ecology, 1992). Airborne particles pose a dual threat to the environment and human health. First, dust can be carried offsite, thereby increasing soil loss from the construction area and increasing the likelihood of sedimentation and water pollution. Second, blowing dust particles can contribute to respiratory health problems and create an inhospitable working environment.

Applicability

Dust control measures are applicable to any construction site where there is the potential for air and water pollution from dust traveling across the landscape or through the air. Dust control measures are especially important in arid or semiarid regions, where soil can become extremely dry and vulnerable to transport by high winds. Implement dust control measures on all construction sites where there will be major soil disturbances or heavy equipment construction activity such as clearing, excavation, demolition, or excessive vehicle traffic. Earthmoving activities are the major source of dust from construction sites, but traffic and general disturbances can also be major contributors (WA Dept. of Ecology, 1992). The dust control measures that are implemented at a site will depend on the topography and land cover of the site and its soil characteristics and expected rainfall.

Siting and Design Considerations

When designing a dust control plan for a site, the amount of soil exposed will dictate the quantity

of dust generation and transport. Therefore, construction sequencing and disturbing only small areas at a time can greatly reduce problematic dust from a site. If land must be disturbed, consider using temporary stabilization measures before disturbance. A number of methods can be used to control dust from a site; not all will be applicable to a site. The owner, operator, and contractors responsible for dust control at a site will have to determine which practices accommodate their needs according to specific site and weather conditions. The following is a brief list of some control measures and design criteria.

Sprinkling/Irrigation. Sprinkling the ground surface with water until it is moist is an effective dust control method for haul roads and other traffic routes (Smolen et al., 1988). This practice can be applied to almost any site.

Vegetative Cover. In areas not expected to handle vehicle traffic, vegetative stabilization of disturbed soil is often desirable. Vegetative cover provides coverage to surface soils and slows wind velocity at the ground surface, thus reducing the potential for dust to become airborne.

Mulch. Mulching can be a quick and effective means of dust control for a recently disturbed area (Smolen et al., 1988).

Wind Breaks. Wind breaks are barriers (either natural or constructed) that reduce wind velocity through a site and, therefore, reduce the possibility of suspended particles. Wind breaks can be trees or shrubs left in place during site clearing or constructed barriers such as a wind fence, snow fence, tarp curtain, hay bale, crate wall, or sediment wall (USEPA, 1992).

Tillage. Deep tillage in large open areas brings soil clods to the surface where they rest on top of dust, preventing it from becoming airborne.

Stone. Stone can be an effective dust deterrent for construction roads and entrances or as a mulch in areas where vegetation cannot be established.

Spray-on Chemical Soil Treatments (palliatives). Examples of chemical adhesives include anionic asphalt emulsion, latex emulsion, resin-water emulsions, and calcium chloride. Chemical palliatives should be used only on mineral soils. When considering chemical application to suppress dust, determine whether the chemical is biodegradable or water-soluble and what effect its application could have on the surrounding environment, including waterbodies and wildlife.

Table 1 shows application rates for some common spray-on adhesives, as recommended by Smolen et al. (1988).

Table 1. Application rates for spray-on adhesives (Source: Smolen et al., 1988)

Spray-on adhesive	Water dilution	Type of nozzle	Application (gal/acre)
Anionic asphalt emulsion	7:1	Coarse spray	1,200
Latex emulsion	12.5:1	Fine spray	235
Resin in water	4:1	Fine spray	300

Limitations

Applying water to exposed soils can be time intensive, and if done to excess, could result in excess runoff from the site or vehicles tracking mud onto public roads. Use chemical applications sparingly and only on mineral soils (not muck soils) because their misuse can create additional surface water pollution from runoff or contaminate ground water. Chemical applications might also present a health risk if excessive amounts are used.

Maintenance Considerations

Because dust controls are dependent on specific site and weather conditions, inspection and maintenance requirements are unique for each site. Generally, however, dust control measures involving application of either water or chemicals require more monitoring than structural or vegetative controls to remain effective. If structural controls are used, inspect them regularly for deterioration to ensure that they are still achieving their intended purpose.

Effectiveness

Mulch. Can reduce wind erosion by up to 80 percent.

Wind Breaks/Barriers. For each foot of vertical height, an 8- to 10-foot deposition zone develops on the leeward side of the barrier. The permeability of the barrier will change its effectiveness at capturing windborne sediment.

Tillage. Roughening the soil can reduce soil losses by approximately 80 percent in some situations.

Stone. The size of the stones can affect the amount of erosion to take place. In areas of high wind, small stones are not as effective as 20 cm stones.

Spray-on Chemical Soil Treatments (palliatives). Effectiveness of polymer stabilization methods range from 70 percent to 90 percent, according to limited research.

Cost Considerations

Costs for chemical dust control measures can vary widely depending on specific needs of the site and the level of dust control desired.

References

Dust Pro, Inc. No date. *Erosion Control*. [www.dustpro.com/Erosion.htm EXIT Disclaime]. Accessed November 10, 2005.

Smolen, M.D., D.W. Miller, L.C. Wyatt, J. Lichthardt, and A.L. Lanier. 1988. *Erosion and Sediment Control Planning and Design Manual*. North Carolina Sedimentation Control Commission; North Carolina Department of Environment, Health, and Natural Resources; and Division of Land Resources, Land Quality Section, Raleigh, NC.

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USEPA (U.S. Environmental Protection Agency). 1992. *Stormwater Management for Industrial Activities: Developing Pollution Prevention Plans and Best Management Practices*. EPA 832-R-92-006. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

Washington State Department of Ecology. 1992. *Stormwater Management Manual for the Puget Sound Basin*. Washington State Department of Ecology, Olympia, WA.

Vegetated Buffers

Minimum Measure: Construction Site Stormwater Runoff Control

Subcategory: Sediment Control

Buffers at the perimeters of construction sites are similar to agricultural buffers in that they trap sediments and remove pollutants in runoff from exposed areas (Source: Nova Scotia Department of Agriculture and Fisheries, 2000)

Description

Vegetated buffers are areas of natural or established vegetation maintained to protect the water quality of neighboring areas. Buffer zones slow stormwater runoff, provide an area where runoff can permeate the soil, contribute to ground water recharge, and filter sediment. Slowing runoff also helps to prevent soil erosion and streambank collapse.

Applicability

Vegetated buffers can be used in any area able to support vegetation. They are most effective and beneficial on floodplains, near wetlands, along streambanks, and on unstable slopes.

Siting and Design Considerations

To establish an effective vegetative buffer, follow these guidelines:

Make sure soils are not compacted.

Make sure slopes are less than 5 percent unless temporary erosion control mats are also used.

Determine buffer widths after carefully considering slope, vegetation, soils, depth to impermeable layers, runoff sediment characteristics, type and amount of pollutants, and annual rainfall.

Make sure buffer widths increase as slope increases.

Intermix zones of vegetation (native vegetation in particular), including grasses, deciduous and evergreen shrubs, and understory and overstory trees.

In areas where flows are concentrated and fast, combine buffer zones with other practices such as level spreaders, infiltration areas, or diversions to prevent erosion and rilling.

Limitations

Adequate land must be available for a vegetated buffer. If land cost is high, buffer zones might not be cost-effective. In addition, adequate vegetative cover must be maintained in the buffer to keep it effective. Vegetated buffers work well with sheet flows, but they are not appropriate for mitigating concentrated stormwater flows.

Maintenance Considerations

Keeping vegetation healthy in vegetated buffers requires routine maintenance. Depending on species, soil types, and climatic conditions, maintenance can include weed and pest control, mowing, fertilizing, liming, irrigating, and pruning. Inspection and maintenance are most important when buffer areas are first installed. Once established, vegetated buffers do not require maintenance beyond the routine procedures and periodic inspections. Inspect them after heavy rainfall and at least once a year. Focus on encroachment, gully erosion, the density of the vegetation, evidence of concentrated flows through the areas, and any damage from foot or vehicular traffic. If more than 6 inches of sediment has accumulated, remove it.

Effectiveness

Several studies indicate greater than 90 percent reductions in sediment and nitrate concentrations when vegetated buffers are used. Buffer/filter strips do a reasonably good job of removing phosphorus attached to sediment, but they are not so effective at removing dissolved phosphorus (Gilliam, 1994).

References

Gilliam, J.W. 1994. Reparian Wetlands and Water Quality. *Journal of Environmental Quality* 23:896-900. Cited in Michigan Department of Environmental Quality. 1998. *Guidebook of Best Management Practices for Michigan Watersheds*. Michigan Department of Environmental Quality, Surface Water Quality Division, Lansing, MI.

Nova Scotia Department of Agriculture and Fisheries. 2000. *Awareness and Communication Project Reports*, Appendix E: Photographs[http://gov.ns.ca/nsaf/ EXIT Disclaimer]. Accessed December 1, 2005.

USEPA (U.S. Environmental Protection Agency). 1992. *Stormwater Management for Industrial Activities: Developing Pollution Prevention Plans and Best Management Practices.* EPA 832-R-92-006. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

USEPA (U.S. Environmental Protection Agency). 1996. *Protecting Natural Wetlands: A Guide to Stormwater Best Management Practices.* EPA 843-B-96-001. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

Gradient Terraces

Minimum Measure: Construction Site Stormwater Runoff Control

Subcategory: Erosion Control

Terraces can be incorporated into the grading plan to shorten the length of the slope and reduce the velocity of stormwater flows (Source: Boaze et. al, 2000)

Description

Gradient terraces are earthen embankments or ridge and channel systems that reduce erosion by slowing, collecting and redistributing surface runoff to stable outlets that increase the distance of overland runoff flow. Terraces hold moisture and help trap sediments, minimizing sediment-laden runoff.

Applicability

Gradient terraces perform most effectively in barren areas with an existing or expected water erosion problem. Gradient terraces are effective only if suitable runoff outlets are available. Do not build terraces on slopes comprised of rocky or sandy soil because these soil types may not adequately redirect flows.

Siting and Design Considerations

Gradient terraces should be properly spaced and constructed with an adequate grade, and they should have adequate and appropriate outlets toward areas not susceptible to erosion or other damage. Acceptable outlets include grassed waterways, vegetated areas, or tile outlets.

General specifications require that:

Whenever possible, use vegetative cover in the outlet.

At the junction of the terrace and the outlet, make the terrace's water surface design-elevation no lower than the outlet's water surface design-elevation when both are performing at design flow.

When constructing the terrace system, follow dust control procedures.
When constructing the terrace system, follow proper vegetation/stabilization practices.

Limitations

Gradient terraces are inappropriate for use on sandy or shallow soils, or on steep slopes. If too much water permeates a terrace system's soils, sloughing could occur, potentially increasing cut and fill costs.

Maintenance Considerations

Inspect the terraces after major storms and at least once annually to ensure that they are structurally sound and have not eroded.

References

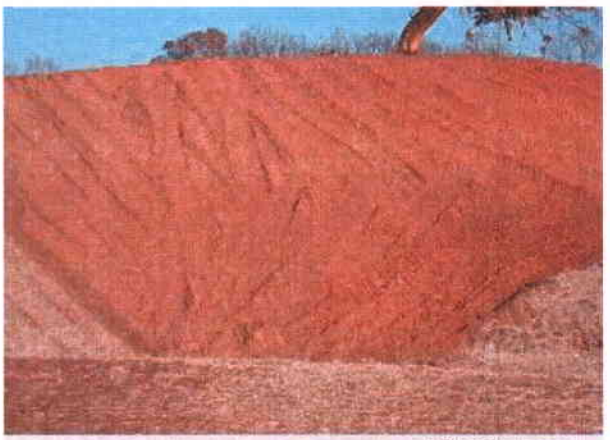
Boaze, P., and B. Wiggins. Building a Major Highway in Mountainous East Tennessee: Environmental Impacts. *Land and Water*. July/August 2000: 20-23.

USEPA (U.S. Environmental Protection Agency). 1992. *StormWater Management for Industrial Activities: Developing Pollution Prevention Plans and Best Management Practices.* EPA 832-R-92-006. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

Land Grading

Minimum Measure: Construction Site Stormwater Runoff Control

Subcategory: Construction Site Planning and Management



Soils exposed from land grading activities are very vulnerable to erosion

Description

Land grading involves reshaping the ground surface to planned grades as determined by an engineering survey, evaluation, and layout. Land grading provides more suitable topography for buildings, facilities, and other land uses and helps to control surface runoff, soil erosion, and sedimentation during and after construction.

Applicability

Land grading is applicable to sites with uneven or steep topography or easily erodible soils, because it stabilizes slopes and decreases runoff velocity. Grading activities should maintain existing drainage patterns as much as possible.

Siting and Design Considerations

Before grading activities begin, a construction site operator must make decisions regarding the steepness of cut-and-fill slopes and how the slopes will be

Protected from runoff
Stabilized
Maintained

Prepare a grading plan that establishes which areas of the site will be graded, how drainage patterns will be directed, and how runoff velocities will affect receiving waters. Also in the grading plan, include information about when earthwork will start and stop, establish the degree and length of finished slopes, and dictate where and how excess material will be disposed of (or

where borrow materials will be obtained if needed). Land grading should be a key consideration for Construction Sequencing. Try to minimize exposed soils at any given time during construction. Incorporate in the plan any berms, diversions, and other stormwater practices that require excavation and filling.

Care should be taken if blasting agents or explosives are used. These products may contain perchlorates, which are water soluble chemicals. If explosives containing perchlorate must be used, then good housekeeping practices should be employed to ensure that any debris is properly disposed.

A low-impact development BMP that a site operator can incorporate into a grading plan is *site fingerprinting*, which involves clearing and grading only those areas necessary for building activities and equipment traffic. Maintaining undisturbed temporary or permanent buffer zones in the grading operation provides a low-cost sediment control measure that will help reduce runoff and offsite sedimentation. Let the lowest elevation of the site remain undisturbed to provide a protected stormwater outlet before storm drains or other construction outlets are installed.

Limitations

Improper grading practices that disrupt natural stormwater patterns might lead to poor drainage, high-runoff velocities, and increased peak flows during storm events. Clearing and grading the entire site without vegetated buffers promotes offsite transport of sediments and other pollutants. Design the grading plan with erosion and sediment control and stormwater management goals in mind; to ensure that the plan is implemented as intended, carefully supervise grading crews.

Maintenance Considerations

Check all graded areas and supporting erosion and sediment control practices periodically, especially after heavy rainfalls. Promptly remove all sediment from diversions or other stormwater conveyances, and if washouts or breaks occur, repair them immediately. To prevent small-scale eroded areas from becoming significant gullies, maintain them promptly.

Effectiveness

Land grading is an effective way to reduce steep slopes and stabilize highly erodible soils when properly implemented with stormwater management and erosion and sediment control practices. Land grading is not effective when drainage patterns are altered or when vegetated areas on the perimeter of the site are destroyed (USEPA, 2004).

Cost Considerations

Land grading is practiced at virtually all construction sites. It can take a certified engineer or landscape architect several hours of work to incorporate stormwater and erosion and sediment controls in the grading plan. It might take extra time to excavate diversions and construct berms. Also, fill materials might be needed to build up low-lying areas or fill depressions. Where grading is performed to manage on-site stormwater, the cost of fine grading, soil treatment, and grassing is approximately $2 per square yard of earth surface area and shallow excavation/trenching (1 to 4 feet deep) with a backhoe in areas not requiring dewatering can be performed for $4 to $5 per cubic yard of removed material (R. S. Means, 2000). Larger scale grading requires a site-specific assessment of an alternative grading apparatus and a detailed fill/excavation material balance to retain as much soil on site as possible.

References

R. S. Means, 2000. *Heavy Construction Cost Data*. 14th Annual Edition. Kingston, MA.

State of Delaware. No date. *Delaware Erosion and Sediment Control Handbook for Development.* Department of Natural Resources and Environmental Control, Division of Water Conservation.

State of North Carolina. 1988. *Erosion and Sediment Control Planning and Design Manual.* North Carolina Sedimentation Control Commission and North Carolina Department of Natural Resources and Community Development, Raleigh, NC.

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APPENDIX B

BMP FACT SHEETS

SILT FENCE

September 1992

Design Criteria

- Silt fences are appropriate at the following general locations:
  - Immediately upstream of the point(s) of runoff discharge from a site before flow becomes concentrated (maximum design flow rate should not exceed 0.5 cubic feet per second).
  - Below disturbed areas where runoff may occur in the form of overland flow.
- Ponding should not be allowed behind silt fences since they will collapse under high pressure; the design should provide sufficient outlets to prevent overtopping.
- The drainage area should not exceed 0.25 acre per 100 feet of fence length.
- For slopes between 50:1 and 5:1, the maximum allowable upstream flow path length to the fence is 100 feet; for slopes of 2:1 and steeper, the maximum is 20 feet.
- The maximum upslope grade perpendicular to the fence line should not exceed 1:1.
- Synthetic silt fences should be designed for 6 months of service; burlap is only acceptable for periods of up to 60 days.

Materials

- Synthetic filter fabric should be a pervious sheet of polypropylene, nylon, polyester, or polyethylene yarn conforming to the requirements in Table 1 below.

TABLE 1. SYNTHETIC FILTER FABRIC REQUIREMENTS

Physical Property	Requirements
Filtering Efficiency	75% - 85% (minimum)
Tensile Strength at 20% (maximum) Elongation	Standard Strength - 30 lb/linear inch (minimum)
	Extra Strength - 50 lb/linear inch (minimum)
Slurry Flow Rate	0.3 gal/ft^2/min (minimum)

- Synthetic filter fabric should contain ultraviolet ray inhibitors and stabilizers to provide a minimum of 6 months of expected usable construction life at a temperature range of 0 to 120°F.
- Burlap of 10 ounces per square yard of fabric can also be used.
- The filter fabric should be purchased in a continuous roll to avoid joints.
- While not required, wire fencing may be used as a backing to reinforce standard strength filter fabric. The wire fence (14 gauge minimum) should be at 22-48 inches wide and should have a maximum mesh spacing of 6 inches.
- Posts should be 2-4 feet long and should be composed of either 2" x 2-4" pine (or equivalent) or 1.00 to 1.33 lb/linear ft steel. Steel posts should have projections for fastening wire and fabric to them.

Construction Specifications

- The maximum height of the filter fence should range between 18 and 36 inches above the ground surface (depending on the amount of upslope ponding expected).

- Posts should be spaced 8 to 10 feet apart when a wire mesh support fence is used and no more than 6 feet apart when extra strength filter fabric (without a wire fence) is used. The posts should extend 12 to 30 inches into the ground.
- A trench should be excavated 4 to 8 inches wide and 4 to 12 inches deep along the upslope side of the line of posts.
- If standard strength filter fabric is to be used, the optional wire mesh support fence may be fastened to the upslope side of the posts using 1 inch heavy duty wire staples, tie wires, or hog rings. Extend the wire mesh support to the bottom of the trench. The filter fabric should then be stapled or wired to the fence, and 8 to 20 inches of the fabric should extend into the trench (Figure 1).
- Extra strength filter fabric does not require a wire mesh support fence. Staple or wire the filter fabric directly to the posts and extend 8 to 20 inches of the fabric into the trench (Figure 1).
- Where joints in the fabric are required, the filter cloth should be spliced together only at a support post, with a minimum 6-inch overlap, and securely sealed.
- Do not attach filter fabric to trees.
- Backfill the trench with compacted soil or 0.75 inch minimum diameter gravel placed over the filter fabric.

Maintenance

- Inspect filter fences daily during periods of prolonged rainfall, immediately after each rainfall event, and weekly during periods of no rainfall. Make any required repairs immediately.
- Sediment must be removed when it reaches one-third to one-half the height of the filter fence. Take care to avoid damaging the fence during cleanout.
- Filter fences should not be removed until the upslope area has been permanently stabilized. Any sediment deposits remaining in place after the filter fence has been removed should be dressed to conform with the existing grade, prepared, and seeded.

Cost

- Silt fence installation costs approximately $6.00 per linear foot.

Sources

- Commonwealth of Virginia - County of Fairfax, 1987. 1987 Check List For Erosion And Sediment Control - Fairfax County, Virginia.
- State of North Carolina, 1988. Erosion and Sediment Control Planning and Design Manual. North Carolina Sedimentation Control Commission, Department of Natural Resources and Community Development.
- Maryland Department of the Environment, 1991. 1991 Maryland Standards And Specifications For Soil Erosion And Sediment Control - Draft.

PIPE SLOPE DRAIN

September 1992

Design Criteria

- Pipe Slope Drains (PSD) are appropriate in the following general locations:
  - On cut or fill slopes before permanent storm water drainage structures have been installed.
  - Where earth dikes or other diversion measures have been used to concentrate flows.
  - On any slope where concentrated runoff crossing the face of the slope may cause gullies, channel erosion, or saturation of slide-prone soils.
  - As an outlet for a natural drainageway.
- The drainage area may be up to 10 acres; however, many jurisdictions consider 5 acres the recommended maximum.
- The PSD design should handle the peak runoff for the 10-year storm. Typical relationships between area and pipe diameter are shown in Table 2 below.

TABLE 2. RELATIONSHIP BETWEEN AREA AND PIPE DIAMETER

Maximum Drainage Area (Acres)	Pipe Diameter (D) (Inches)
0.5	12
0.75	15
1.0	18

Materials

- Pipe may be heavy duty flexible tubing designed for this purpose, e.g., nonperforated, corrugated plastic pipe, corrugated metal pipe, bituminous fiber pipe, or specially designed flexible tubing.
- A standard flared end section secured with a watertight fitting should be use for the inlet. A standard T-section fitting may also be used.
- Extension collars should be 12-inch long sections of corrugated pipe. All fittings must be watertight.

Construction Specifications

- Place the pipe slope drain on undisturbed or well-compacted soil.
- Soil around and under the entrance section must be hand-tamped in 4-inch to 8-inch lifts to the top of the dike to prevent piping failure around the inlet.
- Place filter cloth under the inlet and extend 5 feet in front of the inlet and be keyed in 6-inches on all sides to prevent erosion. A 6-inch metal toe plate may also be used for this purpose.
- Ensure firm contact between the pipe and the soil at all points by backfilling around and under the pipe with stable soil material hand compacted in lifts of 4-inches to 8-inches.
- Securely stake the PSD to the slope using grommets provided for this purpose at intervals of 10 feet or less.
- Ensure that all slope drain sections are securely fastened together and have watertight fittings.

- Extend the pipe beyond the toe of the slope and discharge at a nonerosive velocity into a stabilized area (e.g., rock outlet protection may be used) or to a sedimentation trap or pond.
- The PSD should have a minimum slope of 3 percent or steeper.
- The height at the centerline of the earth dike should range from a minimum of 1.0 foot over the pipe to twice the diameter of the pipe measured from the invert of the pipe. It should also be at least 6 inches higher than the adjoining ridge on either side.
- At no point along the dike will the elevation of the top of the dike be less than 6 inches higher than the top of the pipe.
- Immediately stabilize all areas disturbed by installation or removal of the PSD.

Maintenance

- Inspect regularly and after every storm. Make any necessary repairs.
- Check to see that water is not bypassing the inlet and undercutting the inlet or pipe. If necessary, install headwall or sandbags.
- Check for erosion at the outlet point and check the pipe for breaks or clogs. Install additional outlet protection if needed and immediately repair the breaks and clean any clogs.
- Do not allow construction traffic to cross the PSD and do not place any material on it.
- If a sediment trap has been provided, clean it out when the sediment level reaches 1/3 to 1/2 the design volume.
- The PSD should remain in place until the slope has been completely stabilized or up to 30 days after permanent slope stabilization.

Cost

- Pipe slope drain costs are generally based upon the pipe type and size (generally, flexible PVC at $5.00 per linear foot). Also adding to this cost are any expenses associated with inlet and outlet structures.

Sources

- Commonwealth of Virginia - County of Fairfax, 1987. 1987 Check List For Erosion And Sediment Control - Fairfax County, Virginia.
- State of North Carolina, 1988. Erosion and Sediment Control Planning and Design Manual. North Carolina Sedimentation Control Commission, Department of Natural Resources and Community Development.
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STABILIZED CONSTRUCTION ENTRANCE

September 1992

Design Criteria

- A Stabilized Construction Entrance (SCE) is appropriate in the following locations:
  - Wherever vehicles are leaving a construction site and enter onto a public road
  - At any unpaved entrance/exit location where there is risk of transporting mud or sediment onto paved roads.
- The width should be at least 10 feet to 12 feet or the as wide as the entire width of the access. At sites where traffic volume is high the entrance should be wide enough for two vehicles to pass safely.
- The length should be between 50 to 75 feet in length.
- Flare the entrance where it meets the existing road to provide a turning radius.
- Runoff from a stabilized construction entrance should drain to a sediment trap or sediment basin.
- Pipe placed under the entrance to handle runoff should be protected with a mountable berm.
- Dust control should be provided in accordance with Section 3.2.1.

Materials

- Crushed stone 2-inches-4-inches in diameter
- Geotextile (filter fabric) with the properties listed in Table 3 below.

TABLE 3. GEOTEXTILE REQUIREMENTS

Physical Property	Requirements
Grab Tensile Strength	220 lbs. (ASTM D1682)
Elongation Failure	60 % (ASTM D1682)
Mullen Burst Strength	430 lbs. (ASTM D3768)
Puncture Strength	125 lbs. (ASTM D751) (modified)
Equivalent Opening	Size 40-80 (US std Sieve) (CW-02215)

Construction Specifications

- Clear all vegetation, roots and all other obstructions in preparation for grading.
- Prior to placing geotextile (filter fabric) make sure that the entrance is properly graded and compacted.

- To reduce maintenance and loss of aggregate place geotextile fabric (filter cloth) over the existing ground before placing the stone for the entrance.
- Stone should be placed to a depth of 6-inches or greater for the entire width and length of the SCE.

Maintenance

- Inspect the measure on a regular basis and after there has been a high volume of traffic or storm event.
- Apply additional stone periodically and when repair is required.
- Immediately remove sediments or any other materials tracked onto the public roadway.
- Ensure that associated sediment control measures are in good working condition.

Cost

- Stabilized construction entrances cost ranges from $1,500 to $5,000 to install.

Sources

- Commonwealth of Virginia - County of Fairfax, 1987. 1987 Check List For Erosion And Sediment Control - Fairfax County, Virginia.
- State of North Carolina, 1988. Erosion and Sediment Control Planning and Design Manual. North Carolina Sedimentation Control Commission, Department of Natural Resources and Community Development.
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- Cost Data:
  - Draft Sediment and Erosion Control, An Inventory of Current Practices, April 20, 1990. Prepared by Kamber Engineering for the U.S. Environmental Protection Agency, Office of Water Enforcement and Permits, Washington, D.C. 20460.

FILTER FABRIC INLET PROTECTION

September 1992

Design Criteria

- Inlet protection is appropriate in the following locations:
  - In small drainage areas (less than 1 acre) where the storm drain inlet is functional before the drainage area has been permanently stabilized.
  - Where there is danger of sediment silting in an inlet which is in place prior to permanent stabilization.
- Filter fabric inlet protection is appropriate for most types of inlets where the drainage area is one acre or less.
- The drainage area should be fairly flat with slopes of 5% or less and the area immediately surrounding the inlet should not exceed a slope of 1%.
- Overland flow to the inlet should be no greater than 0.5 cfs.
- This type of inlet protection is not appropriate for use in paved areas because the filter fabric requires staking.
- To avoid failure caused by pressure against the fabric when overtopping occurs, it is recommended that the height of the filter fabric be limited to 1.5 feet above the crest of the drop inlet.
- It is recommended that a sediment trapping sump of 1 to 2 feet in depth with side slopes of 2:1 be provided.

Materials

- Filter fabric (see the fabric specifications for silt fence).
- Wooden stakes 2" x 2" or 2"x 4" with a minimum length of 3 feet.
- Heavy-duty wire staples at least ½ inch in length.
- Washed gravel ¾ inches in diameter.

Construction Specifications

- Place a stake at each corner of the inlet and around the edges at no more than 3 feet apart. Stakes should be driven into the ground 18 inches or at a minimum 8 inches.
- For stability a framework of wood strips should be installed around the stakes at the crest of the overflow area 1.5 feet above the crest of the drop inlet.
- Excavate a trench of 8 inches to 12 inches in depth around the outside perimeter of the stakes. If a sediment trapping sump is being provided then the excavation may be as deep as 2 feet.
- Staple the filter fabric to the wooden stakes with heavy-duty staples, overlapping the joints to the next stake. Ensure that between 12 inches to 32 inches of filter fabric extends at the bottom so it can be formed into the trench.
- Place the bottom of the fabric in the trench and backfill the trench all the way around using washed gravel to a minimum depth of 4 inches.

Maintenance

- Inspect regularly and after every storm. Make any repairs necessary to ensure the measure is in good working order.
- Sediment should be removed and the trap restored to its original dimensions when sediment has accumulated to ½ the design depth of the trap.
- If the filter fabric becomes clogged it should be replaced immediately.
- Make sure that the stakes are firmly in the ground and that the filter fabric continues to be securely anchored.
- All sediments removed should be properly disposed.
- Inlet protection should remain in place and operational until the drainage area is completely stabilized or up to 30 days after the permanent site stabilization is achieved.

Cost

- The cost of storm drain inlet protection varies dependent upon the size and type of inlet to be protected but generally is about $300.00 per inlet.

Sources

- Commonwealth of Virginia - County of Fairfax, 1987. 1987 Check List For Erosion And Sediment Control - Fairfax County, Virginia.
- State of North Carolina, 1988. Erosion and Sediment Control Planning and Design Manual. North Carolina Sedimentation Control Commission, Department of Natural Resources and Community Development.
- Maryland Department of the Environment, 1991. 1991 Maryland Standards And Specifications For Soil Erosion And Sediment Control - Draft.
- Storm Water Management Manual for the Puget Sound Basin. State of Washington, Department of Ecology, 1991.
- Cost Data:
  - Draft Sediment and Erosion Control, An Inventory of Current Practices, April 20, 1990. Prepared by Kamber Engineering for the U.S. Environmental Protection Agency, Office of Water Enforcement and Permits, Washington, D.C. 20460.

EXCAVATED GRAVEL INLET PROTECTION

September 1992

Design Criteria

- Inlet protection is appropriate in the following locations:
  - In small drainage areas (less than 1 acre) where the storm drain inlet is functional before the drainage area has been permanently stabilized.
  - Where there is danger of sediment silting in an inlet which is in place prior to permanent stabilization.
  - Where ponding around the inlet structure could be a problem to traffic on site.
- Excavated gravel and mesh inlet protection may be used with most inlets where overflow capability is needed and in areas of heavy flows, 0.5 cfs or greater.
- The drainage area should not exceed 1 acre.
- The drainage area should be fairly flat with slopes of 5% or less.
- The trap should have a sediment trapping sump of 1 to 2 feet measured from the crest of the inlet. Side slopes should be 2:1. The recommended volume of excavation is 35 yd^3/acre disturbed.
- To achieve maximum trapping efficiency the longest dimension of the basin should be oriented toward the longest inflow area.

Materials

- Hardware cloth or wire mesh with ½ inch openings.
- Filter fabric (see the fabric specifications for silt fence).
- Washed gravel ¾ inches to 4 inches in diameter.

Construction Specifications

- Remove any obstructions to excavating and grading. Excavate sump area, grade slopes and properly dispose of soil.
- The inlet grate should be secured to prevent seepage of sediment laden water.
- Place wire mesh over the drop inlet so that the wire extends a minimum of 1 foot beyond each side of the inlet structure. Overlap the strips of mesh if more than one is necessary.
- Place filter fabric over the mesh extending it at least 18 inches beyond the inlet opening on all sides. Ensure that weep holes in the inlet structure are protected by filter fabric and gravel.
- Place stone/gravel over the fabric/wire mesh to a depth of at least 1 foot.

Maintenance

- Inspect regularly and after every storm. Make any repairs necessary to ensure the measure is in good working order.
- Sediment should be removed and the trap restored to its original dimensions when sediment has accumulated to ½ the design depth of the trap.
- Clean or remove and replace the stone filter or filter fabric if they become clogged.
- Inlet protection should remain in place and operational until the drainage area is completely stabilized or up to 30 days after the permanent site stabilization is achieved.

Cost

- The cost of storm drain inlet protection varies dependent upon the size and type of inlet to be protected but generally is about $300.00 per inlet.

Sources

- Commonwealth of Virginia - County of Fairfax, 1987. 1987 Check List For Erosion And Sediment Control - Fairfax County, Virginia.
- State of North Carolina, 1988. Erosion and Sediment Control Planning and Design Manual. North Carolina Sedimentation Control Commission, Department of Natural Resources and Community Development.
- Maryland Department of the Environment, 1991. 1991 Maryland Standards And Specifications For Soil Erosion And Sediment Control - Draft.
- Storm Water Management Manual for the Puget Sound Basin. State of Washington, Department of Ecology, 1991.
- Cost Data:
  - Draft Sediment and Erosion Control, An Inventory of Current Practices, April 20, 1990. Prepared by Kamber Engineering for the U.S. Environmental Protection Agency, Office of Water Enforcement and Permits, Washington, D.C. 20460.

BLOCK AND GRAVEL INLET PROTECTION

September 1992

Design Criteria

- Inlet protection is appropriate in the following locations:
  - In drainage areas (less than 1 acre) where the storm drain inlet is functional before the drainage area has been permanently stabilized.
  - Where there is danger of sediment silting in an inlet which is in place prior to permanent stabilization.
- Block and gravel inlet protection may be used with most types of inlets where overflow capability is needed and in areas of heavy flows 0.5 cfs or greater.
- The drainage area should not exceed 1 acre.
- The drainage area should be fairly flat with slopes of 5% or less.
- To achieve maximum trapping efficiency the longest dimension of the basin should be oriented toward the longest inflow area.
- Where possible the trap should have sediment trapping sump of 1 to 2 feet in depth with side slopes of 2:1.
- There are several other types of inlet protection also used to prevent siltation of storm drainage systems and structures during construction, they are:
  - Filter Fabric Inlet Protection
  - Excavated Gravel Inlet Protection

Materials

- Hardware cloth or wire mesh with ½ inch openings
- Filter fabric (see the fabric specifications for silt fence)
- Concrete block 4 inches to 12 inches wide.
- Washed gravel ¾ inches to 4 inches in diameter

Construction Specifications

- The inlet grate should be secured to prevent seepage of sediment laden water.
- Place wire mesh over the drop inlet so that the wire extends a minimum of 12 inches to 18 inches beyond each side of the inlet structure. Overlap the strips of mesh if more than one is necessary.
- Place filter fabric (optional) over the mesh and extend it at least 18 inches beyond the inlet structure.
- Place concrete blocks over the filter fabric in a single row lengthwise on their sides along the sides of the inlet. The foundation should be excavated a minimum of 2 inches below the crest of the inlet and the bottom row of blocks should be against the edge of the structure for lateral support.
- The open ends of the block should face outward not upward and the ends of adjacent blocks should abut. Lay one block on each side of the structure on its side to allow for dewatering of the pool.
- The block barrier should be at least 12 inches high and may be up to a maximum of 24 inches high and may be from 4 inches to 12 inches in depth depending on the size of block used.
- Prior to backfilling, place wire mesh over the outside vertical end of the blocks so that stone does not wash down the inlet.
- Place gravel against the wire mesh to the top of the blocks.

Maintenance

- Inspect regularly and after every storm. Make any repairs necessary to ensure the measure is in good working order.
- Sediment should be removed and the trap restored to its original dimensions when sediment has accumulated to ½ the design depth of the trap.
- All sediments removed should be properly disposed of.
- Inlet protection should remain in place and operational until the drainage area is completely stabilized or up to 30 days after the permanent site stabilization is achieved.

Cost

- The cost of storm drain inlet protection varies dependent upon the size and type of inlet to be protected but generally is about $300.00 per inlet.

Sources

- Commonwealth of Virginia - County of Fairfax, 1987. 1987 Check List For Erosion And Sediment Control - Fairfax County, Virginia.
- State of North Carolina, 1988. Erosion and Sediment Control Planning and Design Manual. North Carolina Sedimentation Control Commission, Department of Natural Resources and Community Development.
- Maryland Department of the Environment, 1991. 1991 Maryland Standards And Specifications For Soil Erosion And Sediment Control - Draft.
- Storm Water Management Manual for the Puget Sound Basin. State of Washington, Department of Ecology, 1991.
- Cost Data:
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CHECK DAMS

September 1992

Design Criteria

- Check dams are appropriate for use in the following locations:
  - Across swales or drainage ditches to reduce the velocity of flow.
  - Where velocity must be reduced because a vegetated channel lining has not yet been established.
- Check dams may never be used in a live stream unless approved by the appropriate government agency.
- The drainage area above the check dam should be between 2 acres and 10 acres.
- The dams must be spaced so that the toe of the upstream dam is never any higher than the top of the downstream dam.
- The center of the dam must be 6 inches to 9 inches lower than either edge, and the maximum height of the dam should be 24 inches.
- The check dam should be as much as 18 inches wider than the banks of the channel to prevent undercutting as overflow water re-enters the channel.
- Excavating a sump immediately upstream from the check dam improves its effectiveness.
- Provide outlet stabilization below the lowest check dam where the risk of erosion is greatest.
- Consider the use of channel linings or protection such as plastic sheeting or riprap where there may be significant erosion or prolonged submergence.

Materials

- Stone 2 inches to 15 inches in diameter
- Logs 6 inches to 8 inches in diameter
- Sandbags filled with pea gravel
- Filter fabric (see the fabric specifications for silt fence)

Construction Specifications

- Rock Check Dams
  - Place the stones on the filter fabric either by hand or using appropriate machinery; do not simply dump them in place.
  - Extend the stone 18 inches beyond the banks and keep the side slopes 2:1 or flatter.
  - Lining the upstream side of the dam with ¾ inch to 1¼ inch gravel 1 foot in depth is a suggested option.
- Log Check Dams
  - Logs must be firmly embedded in the ground; 18 inches is the recommended minimum depth.
- Sand Bag Check Dams
  - Be sure that bags are all securely sealed.
  - Place bags by hand or use appropriate machinery.

Maintenance

- Inspect regularly and after every storm. Make any repairs necessary to ensure the measure is in good working order.
- Accumulated sediment and leaves should be removed from behind the dams and erosive damage to the channel restored after each storm or when ½ the original height of the dam is reached.
- All accumulated material removed from the dam shall be properly disposed.
- Replace stone as necessary for the dams to maintain their correct height.
- If sand bags are used, the fabric of the bags should be inspected for signs of deterioration.
- Remove stone or riprap if grass lined channel requires mowing.
- Check dams should remain in place and operational until the drainage area and channel are completely stabilized or up to 30 days after the permanent site stabilization is achieved.
- Restore the channel lining or establish vegetation when each check dam is removed.

Cost

- The costs for the construction of check dams varies with the material used. Rock costs about $100 per dam. Log check dams are usually slightly less expensive than rock check dams. All costs vary depending on the width of channel to be checked.

Sources

- Commonwealth of Virginia - County of Fairfax, 1987. 1987 Check List For Erosion And Sediment Control - Fairfax County, Virginia.
- State of North Carolina, 1988. Erosion and Sediment Control Planning and Design Manual. North Carolina Sedimentation Control Commission, Department of Natural Resources and Community Development.
- Maryland Department of the Environment, 1991. 1991 Maryland Standards And Specifications For Soil Erosion And Sediment Control - Draft.
- Storm Water Management Manual for the Puget Sound Basin. State of Washington, Department of Ecology, 1991.
- Cost Data:
  - Draft Sediment and Erosion Control, An Inventory of Current Practices, April 20, 1990. Prepared by Kamber Engineering for the U.S. Environmental Protection Agency, Office of Water Enforcement and Permits, Washington, D.C. 20460.

September 1992

Design Criteria

- Earth dikes are appropriate in the following situations:
  - To divert upslope flows away from disturbed areas such as cut or fill slopes and to divert runoff to a stabilized outlet
  - To reduce the length of the slope runoff will cross
  - At the perimeter of the construction site to prevent sediment-laden runoff from leaving the site
  - To direct sediment-laden runoff to a sediment trapping device.
- When the drainage area to the earth dike is greater than 10 acres, the United States Department of Agriculture - Soil Conservation Service (USDA - SCS) standards and specification for diversions should be consulted.
- Table 4 contains suggested dike design criteria.

TABLE 4. SUGGESTED DIKE DESIGN CRITERIA

Drainage Area	Under 5 Acres	Between 5-10 Acres
Dike Height	18 inches	30 inches
Dike Width	24 inches	36 inches
Flow Width	4 feet	6 feet
Flow Depth	12 inches	24 inches
Side Slopes	2:1 or less	2:1 or less
Grade	0.5% - 10%	0.5% - 10%

- The base for a dike 18 inches high and 24 wide at the top should be between 6 feet - 8 feet. The height of the dike is measured on the upslope side.
- If the dike is constructed using coarse aggregate the side slopes should be 3:1 or flatter.
- The channel formed behind the dike should have a positive grade to a stabilized outlet. The channel should be stabilized with vegetative or other stabilization measures.
- Grades over 10% may require an engineering design.
- Construct the dike where it will not interfere with major areas of construction traffic so that vehicle damage to the dike will be kept to the minimum.
- Diversion dikes should be installed prior to the majority of soil disturbing activity, and may be removed when stabilization of the drainage area and outlet are complete.

Materials

- Compacted Soil
- Coarse Aggregate

Construction Specifications

- Clear the area of all trees, brush, stumps or other obstructions.
- Construct the dike to the designed cross-section, line and grade making sure that there are no irregularities or bank projections to impede the flow.
- The dike should be compacted using earth moving equipment to prevent failure of the dike.
- The dike must be stabilized as soon as possible after installation.

Maintenance

- Inspect regularly and after every storm, make any repairs necessary to ensure the measure is in good working order.
- Inspect the dike, flow channel and outlet for deficiencies or signs of erosion.
- If material must be added to the dike be sure it is properly compacted.
- Reseed or stabilize the dike as needed to maintain its stability regardless if there has been a storm event or not.

Cost

- The cost associated with earth dike construction is roughly $4.50 per linear foot which covers the earthwork involved in preparing the dike. Also added to this cost is approximately $1.00 per linear foot for stabilization practices. It should be noted that for most construction projects, the cost of earth dike construction is insignificant compared to the overall earthwork project costs.

Sources

- Commonwealth of Virginia - County of Fairfax, 1987. 1987 Check List For Erosion And Sediment Control - Fairfax County, Virginia.
- State of North Carolina, 1988. Erosion and Sediment Control Planning and Design Manual. North Carolina Sedimentation Control Commission, Department of Natural Resources and Community Development.
- Maryland Department of the Environment, 1991. 1991 Maryland Standards And Specifications For Soil Erosion And Sediment Control - Draft.
- Storm Water Management Manual for the Puget Sound Basin. State of Washington, Department of Ecology, 1991.
- Cost Data:
  - Draft Sediment and Erosion Control, An Inventory of Current Practices, April 20, 1990. Prepared by Kamber Engineering for the U.S. Environmental Protection Agency, Office of Water Enforcement and Permits, Washington, D.C. 20460.

DRAINAGE SWALE

September 1992

Design Criteria

- Temporary drainage swales are appropriate in the following situations:
  - To divert upslope flows away from disturbed areas such as cut or fill slopes and to divert runoff to a stabilized outlet
  - To reduce the length of the slope runoff will cross
  - At the perimeter of the construction site to prevent sediment-laden runoff from leaving the site
  - To direct sediment-laden runoff to a sediment trapping device.
- When the drainage area is greater than 10 acres the United States Department of Agriculture - Soil Conservation Service (USDA - SCS) standards and specifications for diversions should be consulted.
- Swales may have side slopes ranging from 3:1 to 2:1.
- The minimum channel depth should be between 12 inches and 18 inches.
- The minimum width at the bottom of the channel should be 24 inches and the bottom should be level.
- The channel should have a uniform positive grade between 2% and 5%, with no sudden decreases where sediments may accumulate and cause overtopping.
- The channel should be stabilized with temporary or permanent stabilization measures.
- Grades over 10% may require an engineering design.
- Construct the swale away from areas of major construction traffic.
- Runoff must discharge to a stabilized outlet.

Materials

- Grass seed for temporary or permanent stabilization
- Sod
- Coarse aggregate or riprap

Construction Specifications

- Clear the area of all trees, brush, stumps or other obstructions.
- Construct the swale to the designed cross-section, line and grade making sure that there are no irregularities or bank projections to impede the flow.
- The lining should be well compacted using earth moving equipment and stabilization initiated as soon as possible.
- Stabilize lining with grass seed, sod, or riprap.
- Surplus material should be properly distributed or disposed of so that it does not interfere with the functioning of the swale.
- Outlet dissipation measures should be used to avoid the risk of erosion.

Maintenance

- Inspect regularly and after every storm, make any repairs necessary to ensure the measure is in good working order.
- Inspect the flow channel and outlet for deficiencies or signs of erosion.
- If surface of the channel requires material to be added be sure it is properly compacted.
- Reseed or stabilize the channel as needed to prevent erosion during a storm event.

Cost

- Drainage swale can vary widely depending on the geometry of the swale and the type of lining material:
  - Grass $3.00/square yard
  - Sod $4.00/square year
  - Riprap $45.00/square year
- No matter which liner type is used, the entire swale must be stabilized (i.e., seeded and mulched at a cost of $1.25/square yard).

Sources

- Commonwealth of Virginia - County of Fairfax, 1987. 1987 Check List For Erosion And Sediment Control - Fairfax County, Virginia.
- State of North Carolina, 1988. Erosion and Sediment Control Planning and Design Manual. North Carolina Sedimentation Control Commission, Department of Natural Resources and Community Development.
- Maryland Department of the Environment, 1991. 1991 Maryland Standards And Specifications For Soil Erosion And Sediment Control - Draft.
- Storm Water Management Manual for the Puget Sound Basin. State of Washington, Department of Ecology, 1991.
- Cost Data:
  - Draft Sediment and Erosion Control, An Inventory of Current Practices, April 20, 1990. Prepared by Kamber Engineering for the U.S. Environmental Protection Agency, Office of Water Enforcement and Permits, Washington, D.C. 20460.

September 1992

Design Criteria

- Temporary sediment traps are appropriate in the following locations:
  - At the outlet of the perimeter controls installed during the first stage of construction.
  - At the outlet of any structure which concentrates sediment-laden runoff, e.g. at the discharge point of diversions, channels, slope drains, or other runoff conveyances.
  - Above a storm water inlet that is in line to receive sediment-laden runoff.
- Temporary sediment traps may be constructed by excavation alone or by excavation in combination with an embankment.
- Temporary sediment traps are often used in conjunction with a diversion dike or swale.
- The drainage area for the sediment trap should not exceed 5 disturbed acres.
- The trap must be accessible for ease of regular maintenance which is critical to its functioning properly.
- Sediment traps are temporary measures and should not be planned to remain in place longer than between 18 and 24 months.
- The capacity of the sedimentation pool should provide storage volume for 3,600 cubic feet/acre drainage area.
- The outlet should be designed to provide a 2 foot settling depth and an additional sediment storage area 1½ feet deep at the bottom of the trap.
- The embankment may not exceed 5 feet in height.
- The recommended minimum width at the top of the embankment is between 2 feet and 5 feet.
- The minimum recommended length of the weir is between 3 feet and 4 feet, and the maximum is 12 feet in length.
- Table 5 illustrates the typical relationship between the embankment height, the height of the outlet (H_o), and the width (W) at the top of the embankment.

TABLE 5. EMBANKMENT HEIGHT vs. OUTLET HEIGHT AND WIDTH

H	H_o	W
1.5	0.5	2.0
2.0	1.0	2.0
2.5	1.5	2.5
3.0	2.0	2.5
3.5	2.5	3.0
4.0	3.0	3.0
4.5	3.5	4.0
5.0	4.0	4.5

Materials

- Filter fabric (see fabric requirement for silt fence)
- Coarse aggregate or riprap 2 inches to 14 inches in diameter
- Washed gravel ¾ to 1½ inches in diameter
- Seed and mulch for stabilization

Construction Specifications

- Clear the area of all trees, brush, stumps or other obstructions.
- Construct the embankment in 8 inch lifts compacting each lift with the appropriate earth moving equipment. Fill material must be free of woody vegetation, roots, or large stones.
- Keep cut and fill slopes between 3:1 and 2:1 or flatter.
- Line the outlet area with filter fabric prior to placing stone or gravel.
- Construct the gravel outlet using heavy stones between 6 inches and 14 inches in diameter and face the upstream side with a 12 inch layer of ¾ inch to 1½ inch washed gravel on the upstream side.
- Seed and mulch the embankment as soon as possible to ensure stabilization.

Maintenance

- Inspect regularly and after every storm. Make any repairs necessary to ensure the measure is in good working order.
- Frequent removal of sediment is critical to the functioning of this measure. At a minimum sediment should be removed and the trap restored to its original volume when sediment reaches ½ of the original volume.
- Sediment removed from the trap must be properly disposed.
- Check the embankment regularly to make sure it is structurally sound.

Cost

- Costs for a sediment trap vary widely based upon their size and the amount of excavation and stone required, they usually can be installed for $500 to $7,000.

Sources

- Commonwealth of Virginia - County of Fairfax, 1987. 1987 Check List For Erosion And Sediment Control - Fairfax County, Virginia.
- State of North Carolina, 1988. Erosion and Sediment Control Planning and Design Manual. North Carolina Sedimentation Control Commission, Department of Natural Resources and Community Development.
- Maryland Department of the Environment, 1991. 1991 Maryland Standards And Specifications For Soil Erosion And Sediment Control - Draft.
- Storm Water Management Manual for the Puget Sound Basin. State of Washington, Department of Ecology, 1991.
- Cost Data:
  - Draft Sediment and Erosion Control, An Inventory of Current Practices, April 20, 1990. Prepared by Kamber Engineering for the U.S. Environmental Protection Agency, Office of Water Enforcement and Permits, Washington, D.C. 20460.

APPENDIX D

MATERIAL SAFETY DATA SHEETS

WARNING! CAUSES IRRITATION TO SKIN, EYES AND RESPIRATORY TRACT. HARMFUL IF SWALLOWED OR INHALED.

SAF-T-DATA(tm) Ratings (Provided here for your convenience)

Health Rating: 1 - Slight
Flammability Rating: 0 - None
Reactivity Rating: 2 - Moderate
Contact Rating: 3 - Severe
Lab Protective Equip: GOGGLES; LAB COAT
Storage Color Code: Green (General Storage)

Potential Health Effects

Inhalation:
Granular material does not pose a significant inhalation hazard, but inhalation of dust may cause irritation to the respiratory tract, with symptoms of coughing and shortness of breath.
Ingestion:
Low toxicity material but ingestion may cause serious irritation of the mucous membrane due to heat of hydrolysis. Large amounts can cause gastrointestinal upset, vomiting, abdominal pain.
Skin Contact:
Solid may cause mild irritation on dry skin; strong solutions or solid in contact with moist skin may cause severe irritation, even burns.
Eye Contact:
Hazard may be either mechanical abrasion or, more serious, burns from heat of hydrolysis and chloride irritation.
Chronic Exposure:
No information found.
Aggravation of Pre-existing Conditions:
No information found.

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4. First Aid Measures

Inhalation:
Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention.
Ingestion:
Induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person. Get medical attention.
Skin Contact:
Wipe off excess material from skin then immediately flush skin with plenty of water for at least 15 minutes. Remove contaminated clothing and shoes. Get medical attention. Wash clothing before reuse. Thoroughly clean shoes before reuse.
Eye Contact:
Immediately flush eyes with plenty of water for at least 15 minutes, lifting lower and upper

eyelids occasionally. Get medical attention immediately.

Note to Physician:
Oral ingestion may cause serum acidosis.

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5. Fire Fighting Measures

Fire:
Not considered to be a fire hazard.
Explosion:
Not considered to be an explosion hazard.
Fire Extinguishing Media:
Use any means suitable for extinguishing surrounding fire.
Special Information:
In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode. At high temperatures or when moistened under fire conditions, calcium chloride may produce toxic or irritating fumes.

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6. Accidental Release Measures

Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8. Spills: Sweep up and containerize for reclamation or disposal. Vacuuming or wet sweeping may be used to avoid dust dispersal. Small amounts of residue may be flushed to sewer with plenty of water.

---

7. Handling and Storage

Keep in a tightly closed container, stored in a cool, dry, ventilated area. Protect against physical damage. Moist calcium chloride and concentrated solutions can corrode steel. When exposed to the atmosphere, calcium chloride will absorb water and form a solution. Containers of this material may be hazardous when empty since they retain product residues (dust, solids); observe all warnings and precautions listed for the product.

---

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
None established.
Ventilation System:

A system of local and/or general exhaust is recommended to keep employee exposures as low as possible. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.

Personal Respirators (NIOSH Approved):
For conditions of use where exposure to dust or mist is apparent and engineering controls are not feasible, a particulate respirator (NIOSH type N95 or better filters) may be worn. If oil particles (e.g. lubricants, cutting fluids, glycerine, etc.) are present, use a NIOSH type R or P filter. For emergencies or instances where the exposure levels are not known, use a full-face positive-pressure, air-supplied respirator. WARNING: Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.

Skin Protection:
Wear protective gloves and clean body-covering clothing.

Eye Protection:
Use chemical safety goggles and/or full face shield where dusting or splashing of solutions is possible. Maintain eye wash fountain and quick-drench facilities in work area.

Other Control Measures:
Maintain good housekeeping in work area. Dust deposits on floors and other surfaces may pick up moisture and cause the surfaces to become slippery and present safety hazards.

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9. Physical and Chemical Properties

Appearance:
White or gray-white granules.

Odor:
Odorless.

Solubility:
Freely soluble in water, exothermic.

Density:
2.15

pH:
8 - 9 Aqueous solution

% Volatiles by volume @ 21C (70F):
0

Boiling Point:
> 1600C (> 2912F)

Melting Point:
772C (1422F)

Vapor Density (Air=1):
No information found.

Vapor Pressure (mm Hg):
No information found.

Evaporation Rate (BuAc=1):
No information found.

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10. Stability and Reactivity

Stability:
Stable under ordinary conditions of use and storage. Substance will pick up moisture from the air and go into solution if exposed in open containers.
Hazardous Decomposition Products:
Emits toxic chlorine fumes when heated to decomposition. May form hydrogen chloride in presence of sulfuric or phosphoric acids or with water at elevated temperatures.
Hazardous Polymerization:
Will not occur.
Incompatibilities:
Methyl vinyl ether, water, zinc, bromine trifluoride, mixtures of lime and boric acid, barium chloride, and 2-furan percarboxylic acid. Metals will slowly corrode in aqueous calcium chloride solutions. Aluminum (and alloys) and yellow brass will be attacked by calcium chloride.
Conditions to Avoid:
Incompatibles.

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11. Toxicological Information

Oral rat LD50: 1000 mg/kg. Investigated as a tumorigen and mutagen.

--------\Cancer Lists\----------

Ingredient	---NTP Carcinogen--- Known	Anticipated	IARC Category
Calcium Chloride (10043-52-4)	No	No	None

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12. Ecological Information

Environmental Fate:
Based on available information for Calcium Chloride anhydrous, this material will not biodegrade or bioaccumulate.
Environmental Toxicity:
The LC50/96-hour values for fish are over 100 mg/l.

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13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste disposal facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with

federal, state and local requirements.

14. Transport Information

Not regulated.

15. Regulatory Information

--------\Chemical Inventory Status - Part 1\---------------------------------

Ingredient	TSCA	EC	Japan	Australia
Calcium Chloride (10043-52-4)	Yes	Yes	Yes	Yes

--------\Chemical Inventory Status - Part 2\---------------------------------

Ingredient	Korea	--Canada-- DSL	NDSL	Phil.
Calcium Chloride (10043-52-4)	Yes	Yes	No	Yes

--------\Federal, State & International Regulations - Part 1\----------------

Ingredient	-SARA 302- RQ	TPQ	------SARA 313------ List	Chemical Catg.
Calcium Chloride (10043-52-4)	No	No	No	No

--------\Federal, State & International Regulations - Part 2\----------------

Ingredient	CERCLA	-RCRA- 261.33	-TSCA- 8(d)
Calcium Chloride (10043-52-4)	No	No	No

Chemical Weapons Convention: No TSCA 12(b): No CDTA: No
SARA 311/312: Acute: Yes Chronic: No Fire: No Pressure: No
Reactivity: No (Pure / Solid)

Australian Hazchem Code: None allocated.
Poison Schedule: None allocated.
WHMIS:
This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

16. Other Information

NFPA Ratings: Health: 1 Flammability: 0 Reactivity: 1

Label Hazard Warning:
WARNING! CAUSES IRRITATION TO SKIN, EYES AND RESPIRATORY TRACT.
HARMFUL IF SWALLOWED OR INHALED.
Label Precautions:
Avoid contact with eyes, skin and clothing.
Wash thoroughly after handling.
Avoid breathing dust.
Keep container closed.
Use only with adequate ventilation.
Label First Aid:
If swallowed, induce vomiting immediately as directed by medical personnel. Never give anything by mouth to an unconscious person. In case of contact, wipe off excess material from skin then immediately flush eyes or skin with plenty of water for at least 15 minutes. Remove contaminated clothing and shoes. Wash clothing before reuse. If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. In all cases, get medical attention.
Product Use:
Laboratory Reagent.
Revision Information:
MSDS Section(s) changed since last revision of document include: 3.
Disclaimer:
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Prepared by: Environmental Health & Safety
Phone Number: (314) 654-1600 (U.S.A.)

MSDS Number: **M0156** * * * * * *Effective Date: 11/04/04* * * * * *Supercedes: 03/28/02*

MSDS Material Safety Data Sheet

From: Mallinckrodt Baker, Inc.
222 Red School Lane
Phillipsburg, NJ 08865

Mallinckrodt CHEMICALS J.T.Baker

24 Hour Emergency Telephone: 908-859-2151
CHEMTREC: 1-800-424-9300

National Response in Canada
CANUTEC: 613-996-6666

Outside U.S. and Canada
Chemtrec: 703-527-3887

NOTE: CHEMTREC, CANUTEC and National Response Center emergency numbers to be used only in the event of chemical emergencies involving a spill, leak, fire, exposure or accident involving chemicals.

All non-emergency questions should be directed to Customer Service (1-800-582-2537) for assistance.

MAGNESIUM CHLORIDE

1. Product Identification

Synonyms: Magnesium chloride, hexahydrate; Magnesium chloride, 6-hydrate, crystal
CAS No.: 7786-30-3 (Anhydrous); 7791-18-6 (Hexahydrate)
Molecular Weight: 203.30
Chemical Formula: MgCl2 6H2O
Product Codes:
J.T. Baker: 2444, 2448, 2449, 2450, 4003, 5183
Mallinckrodt: 12131, 5910, 5933, 5954, 5956, 5958, 5960, 7550, 7791

2. Composition/Information on Ingredients

Ingredient	CAS No	Percent	Hazardous
Magnesium Chloride	7786-30-3	98 - 100%	Yes

3. Hazards Identification

Emergency Overview

CAUTION! MAY BE HARMFUL IF SWALLOWED.

SAF-T-DATA(tm) Ratings (Provided here for your convenience)

Health Rating: 1 - Slight
Flammability Rating: 0 - None
Reactivity Rating: 1 - Slight
Contact Rating: 1 - Slight
Lab Protective Equip: GOGGLES; LAB COAT; PROPER GLOVES
Storage Color Code: Green (General Storage)

Potential Health Effects

Inhalation:
Inhalation of dust may cause mild irritation to the mucous membranes.
Ingestion:
Since magnesium salts are slowly absorbed, abdominal pain, vomiting and diarrhea may be the only symptoms. However, if elimination is blocked by bowel blockage or other reasons, CNS depression, lack of reflexes, hypocalcemia (deficiency of calcium in the blood) may occur.
Skin Contact:
No adverse effects expected but may cause minor skin irritation.
Eye Contact:
No adverse effects expected but dust may cause mechanical irritation.
Chronic Exposure:
No information found.
Aggravation of Pre-existing Conditions:
No information found.

---

4. First Aid Measures

Inhalation:
Remove to fresh air. Get medical attention for any breathing difficulty.
Ingestion:
Give several glasses of water to drink to dilute. If large amounts were swallowed, get medical advice.
Skin Contact:
Remove any contaminated clothing. Wash skin with soap and water for at least 15 minutes. Get medical attention if irritation develops or persists.
Eye Contact:
Wash thoroughly with running water. Get medical advice if irritation develops.

Note to Physician:
IV administration of calcium gluconate will partially reverse the effects of acute magnesium toxicity. Ventricular support with calcium chloride infusion and mannitol forced diuresis has also been successful.

5. Fire Fighting Measures

Fire:
Not considered to be a fire hazard.
Explosion:
Not considered to be an explosion hazard. At room temperature the addition of magnesium chloride to furan-2-peroxycarboxylic acid, will cause the acid to explode.
Fire Extinguishing Media:
Use any means suitable for extinguishing surrounding fire.
Special Information:
In the event of a fire, wear full protective clothing and NIOSH-approved self-contained breathing apparatus with full facepiece operated in the pressure demand or other positive pressure mode.

6. Accidental Release Measures

Ventilate area of leak or spill. Wear appropriate personal protective equipment as specified in Section 8. Spills: Sweep up and containerize for reclamation or disposal. Vacuuming or wet sweeping may be used to avoid dust dispersal.

7. Handling and Storage

Keep in a tightly closed container, stored in a cool, dry, ventilated area. Protect against physical damage. Isolate from incompatible substances. Containers of this material may be hazardous when empty since they retain product residues (dust, solids); observe all warnings and precautions listed for the product.

8. Exposure Controls/Personal Protection

Airborne Exposure Limits:
None established.
Ventilation System:
A system of local and/or general exhaust is recommended to keep employee exposures as low as possible. Local exhaust ventilation is generally preferred because it can control the emissions of the contaminant at its source, preventing dispersion of it into the general work area. Please refer to the ACGIH document, *Industrial Ventilation, A Manual of Recommended Practices*, most recent edition, for details.
Personal Respirators (NIOSH Approved):
For conditions of use where exposure to dust or mist is apparent and engineering controls are not feasible, a particulate respirator (NIOSH type N95 or better filters) may be worn. If

oil particles (e.g. lubricants, cutting fluids, glycerine, etc.) are present, use a NIOSH type R or P filter. For emergencies or instances where the exposure levels are not known, use a full-face positive-pressure, air-supplied respirator. WARNING: Air-purifying respirators do not protect workers in oxygen-deficient atmospheres.

Skin Protection:

Wear protective gloves and clean body-covering clothing.

Eye Protection:

Use chemical safety goggles. Maintain eye wash fountain and quick-drench facilities in work area.

---

9. Physical and Chemical Properties

Appearance:

Colorless flakes or crystals.

Odor:

Odorless.

Solubility:

167g/100ml water @ 20C (68F)

Density:

1.57

pH:

5% in water is neutral to litmus.

% Volatiles by volume @ 21C (70F):

0

Boiling Point:

Not applicable.

Melting Point:

118C (244F)

Vapor Density (Air=1):

No information found.

Vapor Pressure (mm Hg):

No information found.

Evaporation Rate (BuAc=1):

No information found.

---

10. Stability and Reactivity

Stability:

Stable under ordinary conditions of use and storage. By strong ignition is converted into oxychloride.

Hazardous Decomposition Products:

When heated to decomposition it emits corrosive hydrochloric acid vapor. When heated to temperatures above 300C (572F) it emits toxic fumes of chlorine gas.

Hazardous Polymerization:

Will not occur.

Incompatibilities:

Furan-2-peroxycarboxylic acid. Strong oxidizing agents will release chlorine.
Conditions to Avoid:
Heat, moisture, incompatibles.

---

11. Toxicological Information

Oral rat LD50: 8100mg/kg. Investigated as a mutagen.

--------\Cancer Lists\----------

Ingredient	---NTP Carcinogen--- Known	Anticipated	IARC Category
Magnesium Chloride (7786-30-3)	No	No	None

---

12. Ecological Information

Environmental Fate:
No information found.
Environmental Toxicity:
No information found.

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13. Disposal Considerations

Whatever cannot be saved for recovery or recycling should be managed in an appropriate and approved waste disposal facility. Processing, use or contamination of this product may change the waste management options. State and local disposal regulations may differ from federal disposal regulations. Dispose of container and unused contents in accordance with federal, state and local requirements.

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14. Transport Information

Not regulated.

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15. Regulatory Information

--------\Chemical Inventory Status - Part 1\----------

Ingredient	TSCA	EC	Japan	Australia

Ingredient	Korea	Canada DSL	Canada NDSL	Canada Phil.
Magnesium Chloride (7786-30-3)	Yes	Yes	Yes	Yes

--------\Chemical Inventory Status - Part 2\--------

Ingredient	Korea	Canada DSL	Canada NDSL	Canada Phil.
Magnesium Chloride (7786-30-3)	Yes	Yes	No	Yes

--------\Federal, State & International Regulations - Part 1\--------

Ingredient	SARA 302 RQ	SARA 302 TPQ	SARA 313 List	SARA 313 Chemical Catg.
Magnesium Chloride (7786-30-3)	No	No	No	No

--------\Federal, State & International Regulations - Part 2\--------

Ingredient	CERCLA	RCRA 261.33	TSCA 8(d)
Magnesium Chloride (7786-30-3)	No	No	No

Chemical Weapons Convention: No TSCA 12(b): No CDTA: No
SARA 311/312: Acute: Yes Chronic: No Fire: No Pressure: No
Reactivity: No (Pure / Solid)

Australian Hazchem Code: None allocated.
Poison Schedule: None allocated.
WHMIS:
This MSDS has been prepared according to the hazard criteria of the Controlled Products Regulations (CPR) and the MSDS contains all of the information required by the CPR.

---

16. Other Information

NFPA Ratings: Health: 1 Flammability: 0 Reactivity: 0
Label Hazard Warning:
CAUTION! MAY BE HARMFUL IF SWALLOWED.
Label Precautions:
Keep container closed.
Wash thoroughly after handling.
Label First Aid:
If swallowed, give large amounts of water to drink. Never give anything by mouth to an unconscious person. Get medical attention.
Product Use:
Laboratory Reagent.
Revision Information:
MSDS Section(s) changed since last revision of document include: 3.
Disclaimer:
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Prepared by: Environmental Health & Safety
Phone Number: (314) 654-1600 (U.S.A.)

ORICA

Material Safety Data Sheet

Orica Canada Inc.
Maple Street
Brownsburg, PQ
For MSDS Requests: 450-533-4201

Orica USA Inc.
33101 E. Quincy Avenue
Watkins, CO 80137
For MSDS Requests: 303-268-5000

EMERGENCY CONTACTS
FOR EMERGENCIES INVOLVING CHEMICAL SPILL OR RELEASE:
IN CANADA 1-877-561-3636 OR IN USA CHEMTREC AT 1-800-424-9300.

SECTION 1 - CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Name: AMEX, AMEX HD, ANFO **MATS Index:** 59531
MSDS Number: 20100 **Date Issued:** 07 MAY 02
Alternate Name(s): Ammonium Nitrate Fuel Oil.

Product Use: A booster-sensitive blasting agent.

SECTION 2 - COMPOSITION / INFORMATION ON INGREDIENTS

HAZARDOUS INGREDIENT(S)	% (w/w)	ACGIH TWA	CAS NO.
Ammonium Nitrate	90-95	Not Listed.	6484-52-2
Diesel Fuel Oil No. 2	5-10	Not Listed.	68476-34-6

SECTION 3 - HAZARD IDENTIFICATION

Emergency Overview: Risk of explosion when burning. Irritating to eyes. May cause methemoglobinemia. May cause central nervous system (CNS) depression. Read the entire MSDS for a more thorough evaluation of the hazards.

SECTION 4 - FIRST AID MEASURES

General: If you feel unwell seek medical advice (show the label where possible).
Inhalation: Move victim to fresh air. Give artificial respiration ONLY if breathing has stopped. Give cardiopulmonary resuscitation (CPR) if there is no breathing AND no pulse. Oxygen administration may be beneficial in this situation but should only be administered by personnel trained in its use. Obtain medical attention IMMEDIATELY.
Skin Contact: Wash affected areas thoroughly with soap and water. If irritation, redness, or a burning sensation develops and persists, obtain medical advice.
Eye Contact: Immediately flush eyes with running water for a minimum of 20 minutes. Hold eyelids open during flushing. If irritation persists, repeat flushing and obtain medical advice.
Ingestion: If victim is alert and not convulsing, rinse mouth out and give 200-300 mL (1 cup) of water to dilute material. DO NOT induce vomiting. Never give anything by mouth to an unconscious person. If spontaneous vomiting occurs, have victim lean forward with head positioned to avoid breathing in of vomitus, rinse mouth and administer more water. Obtain medical attention IMMEDIATELY.

Note to Physicians: Symptomatic. Administer oxygen if there are signs of cyanosis. If clinical condition deteriorates, consider administering 10 cc Methylene Blue intravenously. It is unlikely for this to be required with methemoglobin level of less than 40%.

SECTION 5 - FIRE-FIGHTING MEASURES

Flash Point: 52oC (125.6oF) (Diesel Fuel Oil No. 2)
Flammable Limits (Lower): Not applicable.
Flammable Limits (Upper): 4.7% (Diesel Fuel Oil No. 2)
Auto Ignition Temperature: 230-265oC (446-509oF)
Decomposition Temperature: Ammonium nitrate will spontaneously decompose at approximately 210oC (410oF)
Rate of Burning: Does not sustain burning at atmospheric pressure.
Explosive Power: 350 - 400 kJ/100 g.
Sensitivity to Mechanical Impact: 250 cm (USBM Report 7840). Not sensitive.
Sensitivity to Static Discharge: Not sensitive.
Hazardous Reactions: See 'Fire and Explosion Hazards'.
Fire and Explosion Hazards: Explodes on overheating when contained and, thus, fires involving large quantities of the material should not be fought. This product is an explosive with a mass detonation hazard. This product is classified as a flammable solid and may detonate under fire conditions.
Extinguishing Media: Water may be used on small fire. Do not attempt to fight large fires.
Fire Fighting Procedures: DO NOT FIGHT FIRES INVOLVING BLASTING AGENTS OR EXPLOSIVE MATERIALS. Immediately evacuate all personnel from the area.
Fire Fighting Protective Equipment: Use self-contained breathing apparatus and special protective clothing.
NOTE: Also see "Section 10 - Stability and Reactivity".

SECTION 6 - ACCIDENTAL RELEASE MEASURES

Spills, Leaks, or Releases: Collect product for re-use or disposal. For release to land, contain storm water runoff by dyking with earth or other barrier, for release to water, utilize damming, and/or water diversion to minimize the spread of contamination. Collect contaminated soil and water for disposal. Notify applicable government authority if release is reportable or could adversely affect the environment.
Deactivating Chemicals: None known.

SECTION 7 - HANDLING AND STORAGE

Handling: This product is an explosive and should only be used under the supervision of trained personnel. Locate safety shower and eyewash station close to chemical handling area. Use normal good industrial hygiene and housekeeping practices.
Storage Requirements: Store under moderate temperatures recommended by technical service representative. Store under dry conditions in a well ventilated

magazine that has been approved for either blasting agent storage or explosive storage.
Do NOT store explosives in a detonator magazine or detonators in an explosive magazine. Keep away from heat, sparks and flames. Keep containers closed. Blasting agents should be kept well away from initiating explosives; protected from physical damage; separated from oxidizing materials, combustibles, and sources of heat. Keep away from incompatibles.
Storage Temperature: Ideal storage temperature is 10-27oC (50-80.6oF).

SECTION 8 - EXPOSURE CONTROLS / PERSONAL PROTECTION

PREVENTIVE MEASURES:
Recommendations listed in this section indicate the type of equipment that will provide protection against overexposure to this product. Conditions of use, adequacy of engineering or other control measures, and actual exposures will dictate the need for specific protective devices at your workplace.
Engineering Controls: Full handling precautions should be taken at all times. General ventilation is recommended. Provide adequate ventilation where operational procedures demand it.
PERSONAL PROTECTIVE EQUIPMENT:
Eye Protection: Use chemical safety goggles when there is potential for eye contact.
Skin Protection: Gloves and protective clothing made from rubber should be impervious under conditions of use. User should verify impermeability under normal conditions of use prior to general use.
Respiratory Protection: A NIOSH/MSHA-approved respirator, if required.
EXPOSURE GUIDELINES:
PRODUCT:
None established for product.
HAZARDOUS INGREDIENT(S):
Ammonium Nitrate:
Internal Guideline 5 mg/m3 (internal TWA)

SECTION 9 - PHYSICAL AND CHEMICAL PROPERTIES

Chemical Name: Not applicable.
Chemical Family: Explosive.
Molecular Formula: Not applicable.
Appearance: Off-white prills.
Odour: Smell of fuel oil.
pH: Not available.
Vapour Pressure (mm Hg at 20°C/68°F): 0.4 (Diesel Fuel Oil No. 2)
Vapour Density (Air=1): Not available.
Boiling Point: 176oC (Diesel Fuel Oil No. 2) to 370oC (Diesel Fuel Oil No. 2) (348.8 to 698oF)
Melting Point: 170oC (338oF)
Solubility (Water): Will dissolve slowly with prolonged exposure to water.
Solubility (Other): Not available.

Specific Gravity: (Similar to water).
Evaporation Rate: Not available.
Additional Properties: Bulk density: 0.8 - 0.88 (poured); 0.92 - 1.10 (pneum. loaded).

SECTION 10 - STABILITY AND REACTIVITY

Hazardous Decomposition Products: Thermal decomposition products are toxic and may include hydrocarbons, oxides of carbon and nitrogen. Toxic gases and vapours (oxides of nitrogen) will be released by thermal decomposition (about 210oC). At higher temperatures, decomposition may be explosive, especially if confined.
Chemical Stability: Stable at room temperature.
Conditions to Avoid: Keep away from heat, impact, and friction. High temperatures, sparks, open flames and all other sources of ignition.
Incompatibility with other Substances: Avoid oxidizable materials, metal powder, bronze & other copper alloys, fuels (e.g. lubricants, machine oils), fluorocarbon lubricants, acids, corrosive liquids, chlorates, sulphur, charcoal, coke and other finely divided combustibles. Reducing agents.
Hazardous Polymerization: Will not occur.

SECTION 11 - TOXICOLOGICAL INFORMATION

Summary: May cause irritation. May cause central nervous system (CNS) depression. May cause methemoglobinemia.
TOXICOLOGICAL DATA:
PRODUCT:
None established for product.
INGREDIENTS:
Ammonium Nitrate:
Oral LD50 (rat) = 2217 mg/kg
Dermal LD50 (rabbit) = 3000 mg/kg
Diesel Fuel Oil No. 2:
LD50 (oral, rat) = >5 g/kg
LD50 (dermal, rabbit) = >5 g/kg
POTENTIAL HEALTH EFFECTS:
Inhalation: Inhalation is not a likely route of exposure at normally encountered temperatures and is thus not applicable.
Skin Contact: May cause skin irritation. Repeated and/or prolonged contact may cause dermatitis.
Eye Contact: Moderate irritant causing moderate initial pain.
Ingestion: Highly unlikely under normal industrial use. Ingestion may cause irritation of the gastrointestinal tract.
Subchronic Effects: Ingestion may cause methemoglobinemia. initial manifestation of methemoglobinemia is cyanosis, characterized by navy blue lips, tongue and mucous membranes, with skin colour being slate grey. Further manifestation is characterized by headache, weakness, dyspnea, dizziness, stupor, respiratory distress and death due to anoxia. If ingested, nitrates may be

reduced to nitrites by bacteria in the digestive tract. Signs and symptoms of nitrite poisoning include methemoglobinemia, nausea, dizziness, increased heart rate, hypotension, fainting and, possibly, shock. CNS depression is characterized by headache, dizziness, drowsiness, nausea, vomiting and incoordination. Severe overexposures may lead to coma and possible death due to respiratory failure.
Chronic Effects: None known.
Carcinogenicity: The ingredients of this product are not classified as carcinogenic by ACGIH (American Conference of Governmental Industrial Hygienists) or IARC (International Agency for Research on Cancer), not regulated as carcinogens by OSHA (Occupational Safety and health Administration) and not listed as carcinogens by NTP (National Toxicology Program).
Mutagenicity: There is no evidence of mutagenic potential.
Reproductive Effects: No information is available and no adverse reproductive effects are anticipated.
Teratogenicity and Fetotoxicity: No information is available and no adverse teratogenic/embryotoxic effects are anticipated.
Synergistic Materials: None known.

SECTION 12 - ECOLOGICAL INFORMATION

Ecotoxicological Information: Harmful to aquatic life at low concentrations.
Environmental Effects: Can be dangerous if allowed to enter drinking water intakes. Do not contaminate domestic or irrigation water supplies, lakes, streams, ponds, or rivers.

SECTION 13 - DISPOSAL CONSIDERATIONS

Burn under supervision of an expert at an approved explosive burning ground or destroy, by detonation in boreholes, in accordance with applicable local, state or provincial, and federal regulations. Call upon the services of an Orica Technical Representative if needed.

SECTION 14 - TRANSPORT INFORMATION

TDG Name: Explosive, Blasting, Type B
TDG Class/Division: 1.5D
Product Identification Number (PIN): UN0331
Packing Group: II
Transportation Emergency Telephone Number: 1-877-561-3636.
DOT Class: Explosive, Blasting, Type B

SECTION 15 - REGULATORY INFORMATION

CANADIAN CLASSIFICATION:
This product has been classified in accordance with the hazard criteria of the CPR (Controlled Products Regulations) and this MSDS (Material Safety Data Sheet) contains all the information required by the CPR.
Controlled Products Regulations (WHMIS) Classification: This product is an explosive and is not regulated by WHMIS.

CEPA / Canadian Domestic Substances List (DSL): The substance(s) in this product is/are on the Canadian Domestic Substances List (CEPA DSL).
IARC Classification: None of the components of this product are listed on IARC.
USA CLASSIFICATION:
Physical: Explosive. Oxidizer.
Health: Irritant.
Target Organ: Eye. Skin. Respiratory tract. Central nervous system. Blood/hematopoietic system.
SARA Regulations Sections 313 and 40 CFR 372: This product contains the following toxic chemical(s) subject to reporting requirements: 94% Ammonium Nitrate (6484-52-2).
Ozone Protection and 40 CFR 42: This product does not contain nor is it manufactured with ozone depleting substances.
Other Regulations/Legislation that apply to this product: Massachusetts Right-to-Know, Pennsylvania Right-to-Know, New Jersey Right-to-Know.

SECTION 16 - OTHER INFORMATION

MATS Index: 59531
Label Text: Danger! Explosive! Strong Oxidizer! May be harmful if ingested. Avoid contact with skin and eyes.
REFERENCES:
RTECS-Registry of Toxic Effects of Chemical Substances, CCINFOdisc, Canadian Centre for Occupational Health and Safety RTECS database, National Institute for Occupational Safety and Health, U.S. Dept. of Health and Human Services, Cincinnati, 1998.
Supplier's Material Safety Data Sheets.
"CHEMINFO", through "CCINFOdisc" Canadian Centre for Occupational Health and Safety, Hamilton, Ontario, Canada
Sax, N. Irving, Dangerous Properties of Industrial Materials, 7th ed., Van Nostrand Reinhold Co., New York, 1989.

Prepared by: Safety, Health and Environment (303) 268-5000.

APPENDIX E

EMERGENCY CONTACTS

Emergency Contacts

Fire, Police, Ambulance		911
National Response Center		(800) 424-8802
Utah Department of Environmental Quality		(801) 536-4123
Utah Division of Water Quality		(801) 538-6146
Vice President – **US** Operations	Harold Roberts	(303) 389-4160
Mine ~~General Superintendent~~ **Compliance Technician**	~~Jim Fisher~~ **Danny Flannery**	~~(970) 677-2702~~ **(435) 678-2221 ext 111**
	Mobile #	~~(970) 739-6994~~ **(435) 681-0121**

APPENDIX F

SPILL REPORT FORM

Spill Report Form

LOCATION:_____

Date:_____ Time:_____

Regulatory agencies notified (date, time, person, agency, and how):_____

Material spilled:_____

Quantity spilled:_____

Source:_____

Cause:_____

Extent of injuries (if any):_____

Adverse environmental impact (if any):_____

Immediate remedial actions taken at time of spill:_____

Measures taken or planned to prevent recurrence:_____

Additional comments:_____

This report prepared by: _____

(Signature)

_____ _____

APPENDIX G

INSPECTION FORM

Stormwater Pollution Prevention Plan ~~for Construction Activities~~

Project Name:_____File No._____

Inspection Date:_____Time:_____ Inspected by: _____

Qualifications of inspector: _____

[ ] 14-day Inspection [ ] Runoff Event Inspection

STAGE OF CONSTRUCTION

___ Pre-Construction Conference ___ Rough Grading ___ Finish Grading
___ Clearing and Grubbing ___ Building Construction ___ Final Stabilization

INSPECTION CHECKLIST

Yes No NA	
[ ][ ][ ]	Are trash receptacles provided on the site, and is the site free of litter?
[ ][ ][ ]	Are hazardous materials being stored in appropriately labeled containers protected from run-on and run-off and in an orderly fashion?
[ ][ ][ ]	Is the concrete washout area located at least 50 ft from the nearest storm drain inlet, drainage facility, and/or watercourse?
[ ][ ][ ]	Are there visible signs of spillage or abnormal run-on/run-off from storage areas, individual BMPs, trash receptacles, concrete washout areas, or signs of illicit discharges?
[ ][ ][ ]	Are discharge points and discharge flows free from noticeable pollutants?
[ ][ ][ ]	Does the stormwater pollution prevention plan (SWPPP), project schedule, phasing, and erosion control operations adequately reflect the current site conditions, contractor operations and BMP implementation?
[ ][ ][ ]	Are there any other potential water pollution control concerns at the site? If yes, please document in the comments section on the last page.
[ ][ ][ ]	Have all areas requiring temporary or permanent stabilization been stabilized?
[ ][ ][ ]	Are sediment basins installed where needed?
[ ][ ][ ]	Do all operational storm sewer inlets have adequate inlet protection?
[ ][ ][ ]	Is in-stream construction conducted using measures to minimize channel damage?
[ ][ ][ ]	Are soil and mud kept off public roadways at intersections with site access roads?
[ ][ ][ ]	Have all control structure repairs and sediment removal been performed?
[ ][ ][ ]	Are properties and waterways downstream from development adequately protected from erosion and sediment deposition?
[ ][ ][ ]	Are spill prevention kits provided near areas where hazardous waste is stored?
[ ][ ][ ]	Are all refueling activities being conducted in the designated refueling area equipped with spill prevention kits and adequate spill clean up supplies?
[ ][ ][ ]	Are impermeable surfaces such as plastic sheeting preventing leaks of materials such as concrete, vehicle maintenance fluids, and/or fuel?
[ ][ ][ ]	Are the sanitary facilities located at least 50 ft from the nearest storm drain inlet, drainage facility, and/or watercourse?

[ ] [ ] [ ] Is dust control (i.e. street cleaning, etc.) routinely implemented and controlled appropriately?

Weather information during inspection:

Temperature: _____ Humidity/Precipitation: _____

Average weather information since the previous inspection:

Temperature: _____ Humidity/Precipitation: _____

Corrective Action Required:	**Date Completed**	**Initials**
1. _____	[/ /]	[ ]
2. _____	[/ /]	[ ]
3. _____	[/ /]	[ ]
4. _____	[/ /]	[ ]
5. _____	[/ /]	[ ]
6. _____	[/ /]	[ ]
7. _____	[/ /]	[ ]
8. _____	[/ /]	[ ]
9. _____	[/ /]	[ ]

Comments: _____
_____
_____
_____
_____

Verbal/Written notification given to: _____

Inspector Signature: _____ Date: _____

APPENDIX H

TRAINING SIGNATURE SHEET

TRAINING SIGNATURE SHEET

By signing this sheet, I am attesting to the fact that I have read this plan and agree to abide by the principles and best management practices established in this stormwater management plan.

Name (print)	Name (signature)

APPENDIX I

PHOTOGRAPHIC LOG

APPENDIX J

ADDITIONAL NOTES

ADDITIONAL NOTES

Project Name: _____
Name: _____
Title: _____
Date: _____

Observation Activity:

_____

_____

_____

_____

Notes:

_____

_____

_____

_____

Follow-up Required:	**Date Completed**	**Initials**
1. _____	[/ /]	[ ]
2. _____	[/ /]	[ ]
3. _____	[/ /]	[ ]
4. _____	[/ /]	[ ]
5. _____	[/ /]	[ ]
6. _____	[/ /]	[ ]
7. _____	[/ /]	[ ]
8. _____	[/ /]	[ ]

APPENDIX K

PLAN DEVIATIONS RECORDING FORM

PLAN DEVIATIONS RECORDING FORM

Signature: _____ **Date:** _____

Description of Change: